THE GLASS INDUSTRY

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HOW PLEXITE IS MADE AND TESTED

In the field of laminated safety glasses Plexite presents many unusual features. This is the first published description of the novel and interesting manufacturing processes developed by the American Window Glass Co. for the production of Plexite glass.

THE laminated safety glass now being produced commercially by the American Window Glass Co. under the name Plexite differs quite radically from other types, both in physical properties and in the process of manufacture. Under the impact of a heavy blow the glass cracks and yields, but the sheet holds together by virtue of the rubber-like characteristic of the binder. In the process of manufacture this binder is flowed onto the glass in the form of a liquid, instead of being inserted in the form of a sheet, as in all other types. Impervious to moisture and apparently unaffected by light or ordinary variations in temperature, the "ham" in the Plexite sandwich is an acrylic resin, called Plexigum.

Chemically, Plexigum is a mixture of polymers of acrylic acid, and might be non-technically described as a transparent artificial rubber. The polymers of the acrylates and methacrylates can be produced in a wide variety of forms; but as a class they are distinguished from other resins by their colorless transparency, adhesive qualities, great elasticity and resistance to many reagents. The brilliant water-white color of the polymers makes it possible to secure masses with high light transmission and great optical clarity and, because of the remarkable stability of the polymers against the action of light and heat, these qualities are permanent. Plexigum is made by a complicated process developed and patented by the Röhm & Haas Co., Philadelphia. All of the machinery and processes for utilizing Plexigum in the manufacture of laminated safety glass were developed by the American Window Glass Co. and are in operation at its Jeannette, Pa., plant.

As received from the manufacturer in fifty-gallon drums, Plexigum includes the rubber-like polymer of acrylic acid and other substances, together with suitable plasticizers, dissolved in ethylene dichloride, all forming a colloidal suspension that has very much the same consistency as molasses. The material is prepared for use in three large, tin-lined, steam-jacketed kettles which are located on the second floor of the preparation building so that the prepared gum flows to the filming machine by gravity. Fig. 1 shows the arrangement of the three kettles, each of which holds 3,000 pounds of gum. To begin the process, six drums of Plexigum are drawn into one of the kettles by means of a vacuum and the kettle is then heated to a temperature of 140 deg. F. During the entire process the gum is slowly stirred by electrically-driven paddles and, as the required temperature is reached, a vacuum is applied causing the gum and solvent mixture to boil and foam violently. This is continued for an hour and in this time all of the air dissolved in the gum during transit is removed. Cold water is now circulated through the jacket to bring the contents of the kettle back to room temperature and the gum remains at this temperature throughout the filming operation.

The kettles are used alternately to keep the preparation process continuous and the entire process, from the time the Plexigum is introduced until it is ready for use at the proper temperature, requires about ten hours. The three kettles are connected to a common filter by brass pipe lines beneath the floor, as shown in Fig. 2, the flow of gum being controlled by suitable valves in these lines. The filter incorporates two 500-mesh screen cylinders, either of which may be used while the other is being cleaned or repaired, and from the filter the Plexigum flows through a pipe into the filming machine room.

Before being placed in the filming machine the glass is prepared with equal care. The sheets are already cut to pattern and the side of each sheet that is to receive the film of Plexigum is first covered with a special cleaner, developed by the American Window Glass Co. to produce a satisfactorily clean surface. The glass then passes through a standard L-O-F washing machine built by the Kent-Owens Machine Co. which

Fig. 1. The arrangement of three kettles, each of which holds 3,000 pounds of gum.

rinses the cleaner from the glass with a spray of pure water at 180 deg. F. The sheets are dried by passing between rubber rolls and, after inspection, are ready for the filming operation.

The filming process

The filming process is the heart of the Plexite manufacturing procedure and the automatic machine for performing this important operation is illustrated in Fig. 3. The machine consists of a double-chain conveyor twenty feet long, mounted in a suitable framework and arranged to carry the glass sheets under the filming trough which is mounted near the center of the machine. The aluminum cross-slats of the conveyor are attached to the chains at either end and carry wooden blocks two inches high on which the sheets of glass are laid. An adjustable-speed motor drives the conveyor at speeds ranging from 20 to 150 inches per minute, carrying the glass smoothly and steadily under the trough to insure the production of a film of unvarying thickness.

The pipes carrying the prepared Plexigum to the two filming machines enter the filming room through the wall and the material flows by gravity into the filming trough on each machine. As shown in Figs. 4 and 5, the stainless steel trough, or feeder, performs the function of laying a perfectly uniform film of Plexigum on the glass, the width of which may be as much as 48 inches. The trough is triangular in cross-section and the side toward the oncoming glass is carried down to within a quarter inch of the glass surface, the other side being mounted so that there is a slot at the apex of the triangle extending the entire length of the trough. The width of the slot is adjustable to suit the requirements of various thicknesses of film. The flow of the gum from the feed pipe is regulated to maintain a depth of about three inches of material in the trough. Before reaching the lip of the filming trough the glass passes under a brush and all dust particles are removed by a vacuum system. Glass covers are placed over the conveyor to prevent the entrance of dirt and dust and to reduce air currents.

The thickness of the binder in the finished product is determined by the thickness of the film laid on the glass and this is controlled by the speed of the conveyor, the width of the feeder slot and the depth or head of gum in the trough. The thickness of the film may vary from 0.015 to 0.050 inches, or more, depending on the type of safety glass to be made, and the width of the film flowing from the trough may range from 12½ to 49½ inches. The flow characteristics of the Plexigum are controlled by the constituents of the mixture and the temperature at the machine, so arrangements are made to keep the room in which the process is conducted at a uniform temperature and to eliminate dust from the atmosphere as far as possible. It is also necessary to adjust the position of the feeder trough carefully and to maintain proper alignment, level, etc., to produce a perfect film.

The width of the film flowing from the feeder trough lip is such that it overflows the glass at the sides, as shown in Fig. 5. There is also some overflow between the sheets. The total amount of gum in the overflow may be as much as 35 per cent of the gum filmed, as in the case of door glass for automobiles with large radii in the corners. All of the overflowing gum is collected in metal troughs and returned by a vacuum method to be used over again.

Fig. 2. The brass pipes which connect the three kettles to a common filter.

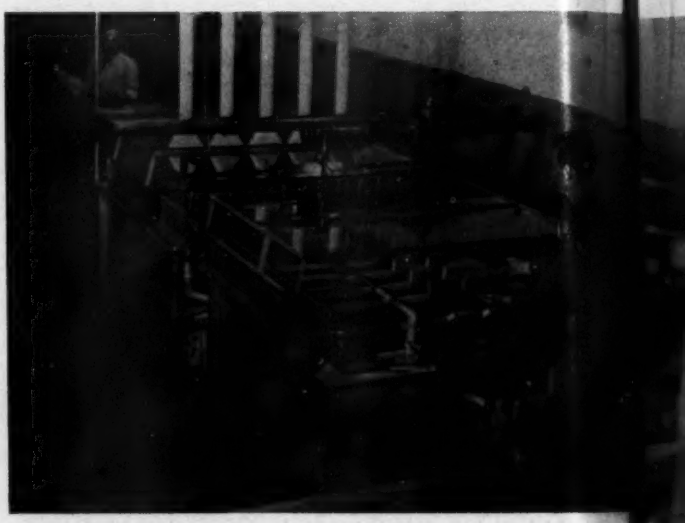


Fig. 3. The automatic machine for the filming process.

After the filming is completed there are two sheets of glass for each complete laminated piece, each covered on one side with a uniform layer of Plexigum having an average thickness of about 0.0105 inches. Besides the required solids and plasticizers this film still contains ethylene dichloride, which must now be removed by drying.

Drying the film

The drying program involves holding the coated glass sheets at a temperature just below the boiling point of the solvent for a certain period, during which time most of the solvent is evaporated. Then the temperature is raised to remove the remaining solvent quickly, leaving a coating which is substantially free of solvent, but still slightly tacky and flexible to the touch. The complete drying operation takes from 30 to 55 minutes, depending on the thickness of the film, and is performed in a continuous oven of special design.

The continuous drying oven is 263 ft. long by 4 ft.

Fig. 4. The stainless steel trough or feeder lays a perfectly uniform film of Plexigum on the glass.

Fig. 5. Another view of the feeder and the equipment for laying Plexigum on the glass.

wide inside and consists of an insulated metal housing, through which the glass sheets are carried on a continuously moving conveyor. The conveyor is of the double-chain type with wooden slats spaced six inches apart and is driven by an adjustable-speed motor, similar to the one used on the filming machine. Fig. 6 illustrates the discharge end of the oven, together with the driving motor and reduction gear. At present the oven is loaded by hand, though mechanical means can be used, and the speed of the oven conveyor is synchronized with the filming conveyor to give a continuous flow of filmed glass.

Spaced throughout the drying tunnel, in the proper positions to produce the heating cycle mentioned above, are 250 Cooper-Hewitt heating elements. These elements are located one foot above the glass, each unit being 48 in. long and drawing 2.9 amperes at 220 volts. Underneath and two inches below each heating element is placed a strip of copper screening whose function is to diffuse the radiant heat, break up any air currents, and prevent "hot spots". The heating elements are connected in three groups, each of which serves about one-third of the oven, and the circuit for each group is controlled by rheostats to make provision for changes in room temperature, etc. In order to diminish the outside effects as much as possible, however, room temperatures are carefully controlled and the entire oven is insulated with one-inch cork board. Control temperature readings are regularly taken at 54 points along the oven conveyor.

A constant drift of ventilating air is maintained in the oven to prevent dangerous concentration of the ethylene dichloride vapor and to assist in the drying. On account of the weight of the vapor the ventilating flow is from top to bottom of the oven and the ventilating air is, therefore, admitted through one-inch slots in the top of the oven housing. Spaced every two feet along the length of the oven, these slots extend clear across the oven and are equipped with air filters. The bottom of the oven housing consists of a series of funnel-shaped air outlets from which two variable-speed fans draw the air and vapor from the oven through 12-inch galvanized pipes.

The coated glass sheets leave the drying oven at a temperature of about 220 deg. F. and, as stated previously, the film is still slightly tacky and flexible to the touch.

Inspection and assembly

The apparatus used for inspection and assembly of the filmed glass sheets is shown in Fig. 7. The first section consists of a light box over which the glass passes on rubber-tired idler wheels as it is inspected. The sheets then pass under a horizontal pipe which showers the surface of the film with an oil-like contacting agent and are received on rubber-covered rolls at the point where they are assembled. After assembly the completed sandwich is passed between rubber wringer rolls and is ready for the next operations.

At the inspection position the occasional bubble which may form in the film during drying is punctured with a steel hypodermic needle and filled with the oil-like contacting agent mentioned above. The light box is furnished with two Cooper-Hewitt mercury-arc lights and the inspectors check the film for dirt and other defects, as well as bubbles. At the assembly position each of the operators grasps a sheet, the bottom edges are placed together, and the sheets are then brought together in such a way that the liquid contacting agent washes out all air bubbles from between the sheets. The liquid is only slightly absorbed by the film, but the absorbed portion has some plasticizing action.

The soft rubber wringer rolls, between which the sandwich passes after assembly, perform the function of squeezing out the excess liquid and uniting the two films. The pressure on the wringer rolls is maintained at the proper point by utilizing compressed air, thus providing accurate pressure control. The operator at the end of the machine removes the Plexite sandwich from the rolls and gives the edge-matching a final check, since adjustments are impossible beyond this point. The sandwich is then placed against an A-frame on a small truck, resting on narrow wooden strips at the bottom and separated from its neighbors by thin strips of wood which hang from the top of the rack. Each small truck holds about 120 square feet of glass.

Fig. 7. The apparatus used for inspection and assembly of the filmed glass sheet.

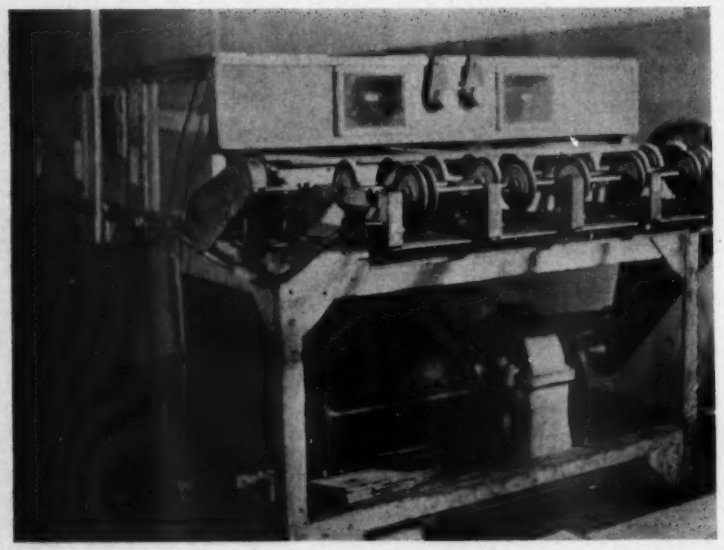


Fig. 6. The discharge end of the oven together with the driving motor and reduction gear.

Fig. 8. The automatic Klages edge-grinding machine used on large runs.

Fig. 9. Illustrating the second cut being made directly over the first which is on the opposite side of the sheet.

Pressure Cooling

The apparatus in which the Plexite sandwiches are cooled under pressure consists of a large horizontal, cylindrical, steel chamber, inside of which is another chamber four feet square in cross-section and twelve feet long. As soon as possible after assembly two truck loads of the laminated glass are placed in the inner chamber and the cover at the end of the large cylinder is tightly closed. The air pressure inside the apparatus is then raised to between 50 and 75 lb. per sq. in. The inner chamber is perforated at top and bottom and arrangements are provided to circulate a large volume of the high-pressure air at room temperature downward over and between the sheets of glass. The circulating air may be cooled with water to hasten the cooling of the glass sandwiches. The pressure cooling quickly completes the processing of the Plexite binder and the laminated sheets are now ready for final finishing, cleaning and packing.

Cleaning and Finishing

Since Plexigum is impervious to water and adheres so tenaciously to the glass surface, the edge of the Plexite sandwich is self-sealed and the usual operation of edge-sealing is not necessary. After cooling the excess Plexigum is removed from the edges by steel brush wheels which also break down the sharp edges of the glass and make it easier and safer to handle. For many purposes this is all the edge grinding required, but a certain percentage of the product, such as door lights, require ground and polished edges.

When the production of a given pattern is small the edges are ground and polished by hand, but on large runs automatic Klages edge-grinding machines, illustrated in Fig. 8, are employed. These machines handle four laminated sheets at one time, the sheets being held in position by rubber grips. As the sheets rotate slowly about a horizontal axis the edges are in contact with movable grinding wheels which are positioned by hardened aluminum templates. During one revolution of the glass-carrying spindle three edges of each sheet are completely ground and polished, the operation being completed in two minutes.

After the edges are finished the Plexite is put through a scrubbing machine in which rapidly revolving brushes apply a soap solution to both sides of the glass to absorb the excess of contacting liquid which still clings to the surface. As the glass leaves the scrubber an operator sand-blasts the Plexite trade mark in the corner and passes the sheet into another washing machine, similar to the one used to prepare the glass for the filming operation. This machine washes the soap solution from the glass and dries it between rubber squeegee rollers. Inspectors remove the finished Plexite sheets from the machine and place it in packing cases or on trucks.

The flexibility of the Plexite binder permits cutting the laminated sheet to any required shape after fabrication, a property which is of value in the easy replacement of automobile glass. To make such a cut the glass is first scratched on one side and the cut is broken through the one thickness of glass by pressing on the surface. Then a second cut is made on the other side, as shown in Fig. 9, care being taken that the second cut is directly over the first. The Plexigum binder is then easily cut through with a razor blade or sharp knife. When only a few of one pattern are to be cut the operator can lay the sheet directly on the blueprint and follow the contour, but for large quantities a template cutting machine can be used to cut the pattern on both sides of the glass at once.

Properties and Testing Methods

Desirable properties in a safety glass for automobiles include (1) resistance to impact; (2) a yielding break to minimize the danger of skull fracture and similar injuries; (3) permanence; (4) retention of characteristics throughout the ordinary range of driving temperatures; (5) unimpaired vision through high light transmission, small distortion, and a minimum of haze, dirt or opalescence in the binder; (6) ease of breaking out when occupants of a car are trapped inside; (7) sound proofing; and (8) ease of installation and replacement.

The standard test for resistance to impact is to drop a half-pound steel ball from a height of 16 feet within one inch of the center of a sample 12 inches square, the sample being held in a solid wooden frame, as illustrated in Fig. 10. In this test the standard requirement is that the glass may shatter, but the ball must not

go through the glass nor must it even puncture a hole in the glass in more than 20 per cent of the samples. Fig. 10 shows the action of Plexite under this test, the broken glass and the binder forming a net which holds the ball.

The yielding break is considered by many to be of prime importance, because of the high fatality from skull fracture automobile accidents. As a standard test, an eleven-pound bag of shot is dropped on a 12 x 12 sheet of Plexite with the results shown in Fig. 11. In this test the bag was dropped from a height of five feet. As a test for permanence Plexite is exposed to the rays of a powerful ultra-violet, mercury-arc light for the equivalent of many years of sunlight and shows no change. It has also been exposed to the weather on the roof of the plant for seven years without discoloration, according to the test records of the manufacturer.

The standard temperature for the impact test mentioned above is between 75 and 80 deg. F. But standard commercial Plexite with a film thickness of 0.020 in. is also tested through a range from 15 to 120 deg. F., so that its safety characteristics will be available throughout the normal range of driving temperatures. Test records on Plexite made with sheet glass show a light transmission of 92 per cent and distortion is reduced by an interesting inherent quality of the Plexigum binder. Plexigum has the same refractive index as the glass, so the light is not bent as it passes between the binder and the adhering layers of glass, the result of this combination of properties being a low haze value.

Tests also indicate that Plexite can be broken quite easily to release entrapped occupants of a car and that the flexible binder is effective as a sound and vibration deadener, thus reducing both outside noises and car noise.

Two types of Plexite have been developed for use in airplanes. The first is made from two sheets of glass of lantern-slide thickness with a Plexigum film twice as thick as in standard automobile safety glass. Although the total thickness is only about ⅛ inch, with about half the weight of standard ¼-inch laminated glass, this special Plexite withstands three times the standard test for resistance to impact. It was first chosen for its soundproofing properties. The second type was developed for use in airplane windshields and incorporates two 0.070-inch sheets of plate glass, three 0.033-inch sheets of sheet glass, and four films of Plexigum. The plate glass is placed outside and the sheet glass inside, where the Plexigum causes all possible distortion to disappear, making the unit the equivalent of all plate. The total thickness of this type of Plexite is ⅜ of an inch.

The entire development of the materials, processes and equipment described in this article has taken place during the past seven years and the commercial production of Plexite is an outstanding achievement. When it is realized that the manufacture of safety glass in various forms has been the fastest growing component of the entire glass industry during the past decade, the advent of this product and its novel manufacturing process is of consequence. Its progress in a field which has witnessed so many revolutionary changes and in which so much research is being carried on at the present moment, will be observed with greatest interest.

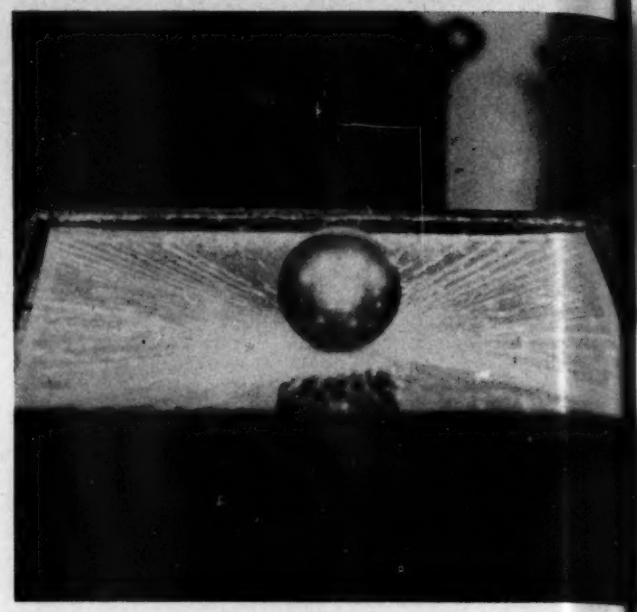
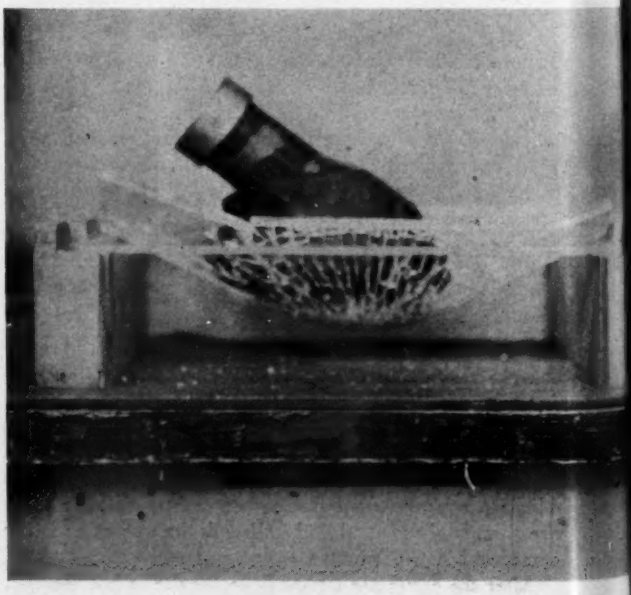


Fig. 10. The standard test for resistance to impact.

Fig. 11. The standard test for the yielding break, which is an important factor in glass for automobiles.



COLORFUL NEW ORLEANS CALLS THE A. C. S.

American Ceramic Society plans an eventful celebration of its Fortieth Anniversary—special train will take ceramists to the Southland. Glass Division sessions Tuesday and Wednesday afternoons

For the first time in its history the American Ceramic Society is invading the deep South and will hold its annual meeting March 27 to April 2 in New Orleans. For all Northerners, at the fag end of a wintry season marked by snow, ice and chilling winds, no more delightful spot could have been selected. A land of sunshine and smiling skies, the center of the old Creole culture—picturesque, yet outstandingly modern in its industrial set-up—New Orleans is one of the most colorful of all our American cities.

And so it is fitting that the Society should choose a city outstandingly different as the place to celebrate the important occasion of its Fortieth Anniversary. No pains have been spared to make the meeting correspondingly eventful. The importance of the technical program can be judged on its own merits, complete abstracts of all papers of interest to glass men appearing on subsequent pages. Evening entertainments will be of such a type as only a city like New Orleans could provide. Time is allotted on an otherwise very full schedule to visit points of interest, to inspect the modern industrial South, for golf, for social activities; in short, to make the trip itself one of great educational value and at the same time combine with the serious business of glass-making a judicious mixture of recreation.

Important among the features of this year's meeting to emphasize is the special train provided to take the ceramists South from Cincinnati. Special cars will be made up at points of concentration: such as New York, Pittsburgh and Columbus, all of them converging Saturday morning in Cincinnati. There the whole party will breakfast together in the magnificent Cincinnati Terminal, which in itself exemplifies many of the uses of ceramics for modern decoration. After breakfast the party will board the special train and proceed on its journey southward, arriving in New Orleans at 7:55 A.M. Sunday. In this way, every delegate can make use of the time spent in comfortable travel to meet his fellow ceramists and exchange glass house chatter.

Many, through habit, think of New Orleans as a distant city quite expensive to reach. As a matter of fact such is not the case. The round trip from New York to New Orleans is $64.85 and from Chicago to New Orleans and return is $42.25. The slight increase in travel expense is more than offset by the low cost of everything in New Orleans.

Except for the short lay-over at Cincinnati, the trip southward is non-stop. Stop-overs, and special trips, must therefore be made homeward bound. On the map (see page 92) are shown a number of the main points of interest that may be seen at no additional cost—one may select any routing he wishes for the return trip, providing he indicates (in most cases) his choice when purchasing his ticket at the time of departure.

Members of the American Ceramic Society have all received copies of the "official itinerary," showing time of departure from many of the principal cities, transportation costs, etc. Others planning to make the trip

Old New Orleans: Courtyard of a home in the French Quarter.

New New Orleans: Canal Street completely rebuilt in 1930.

should consult with any member of the local transportation committee listed on page 92, who will be glad to answer any questions and help with arrangements:

Reservations should be made at once so that the committee may know how many special cars to provide. Failure to do this might result in inferior accommodations and mar the pleasure of your trip.

Principal times of departure

Although the Chicago party will travel separately on the Illinois Central R. R., leaving Chicago at 1:00 P.M. Saturday, other ceramists will leave the following principal cities at the hours indicated below.

Friday, March 25

Baltimore, Md.—7:19 P.M.
Boston, Mass.—7:30 A.M.
Buffalo, N. Y.—11:45 P.M.
Cleveland, O.—12:15 A.M.
Corning, N. Y.—4:52 P.M.
Detroit, Mich.—11:00 P.M.
East Liverpool, O.—3:00 P.M.
Hartford, Conn.—10:00 A.M.
Hornell, N. Y.—5:12 P.M.
Jersey City, N. J.—3:43 P.M.
Martinsburg, W. Va.—10:08 P.M.
New York, N. Y.—2:55 P.M.
Philadelphia, Pa.—5:11 P.M.
Pittsburgh, Pa.—10:10 P.M.
Schenectady, N. Y.—6:29 P.M.
Syracuse, N. Y.—8:57 P.M.
Washington, Pa.—11:09 P.M.
West Trenton, N. J.—4:45 P.M.
Wheeling, W. Va.—12:10 A.M.

Saturday, March 26

Birmingham, Ala.—9:10 P.M.
Cincinnati, O.—10:00 A.M.
Indianapolis, Ind.—8:40 A.M.
Louisville, Ky.—12:22 P.M.
Nashville, Tenn.—4:45 P.M

If you travel by automobile

Through the courtesy of the American Automobile Association, THE GLASS INDUSTRY has been able to assemble certain automobile routes (see accompanying map) recommended not only on the basis of good roads but also rich in points of scenic and historic interest. Four starting points for New Orleans have been selected: New York, Pittsburgh, Columbus and Chicago.

The first part of the trip, starting from New York, is largely through industrial centers such as Newark, Elizabeth, Trenton, and Wilmington to Baltimore and then on to Washington, D. C. Leaving Washington, the route follows to Warrenton, Va., where Route 211 brings the motorist to the famous Skyline Drive, through the beautiful Shenandoah National Park and on through the Blue Ridge Mountains to Natural Bridge. Here it would be possible to take a short side trip (approximately 40 miles) to White Sulphur Springs. Then on to Roanoke and via Route 11 to Johnson City. From here there is a choice of two routes. One is by way of Asheville, famous North Carolina resort, to Dillsboro. Perhaps the more interesting though somewhat longer route is by way of Knoxville, which will make possible an inspection of the mammoth Norris Dam. The route from Knoxville to Dillsboro through the Great Smoky Mountains is said to be one of the most spectacular scenic drives in America. On from Dillsboro, to Gainsville, Atlanta, Montgomery and Mobile. The trip from Mobile to New Orleans along Mississippi's beautiful Gulf Coast, through such interesting points as Pascagoula, Biloxi, Pass Christian and Bay St. Louis, offers a real treat to the motorist who has never made this trip before.

While the routes recommended from the other points are less interesting scenically, they are more direct, and follow in general the direction taken by the railroads. From Pittsburgh, Route 22 goes through Zanesville to Washington Court House. From Columbus, Route 62 runs to Washington Court House. And both Pittsburghers and Columbians follow Route 22 to Cincinnati; then Louisville to Horse Cave, where a short side trip (about 20 miles) will bring them to Mammoth Cave National Park. Along Route 31 to Nashville, where they will be joined by the Chicagoans who have followed an almost straight line along Route 41. At Athens, Ala., a very interesting side trip (about 40 miles) to Wilson Dam and Wheeler Dam may be made. Then back onto Route 31 to Birmingham and Montgomery. Here the Middle Westerners will follow the same route as the Easterners to Mobile and along the Gulf Coast to New Orleans.

Optional return routes

The following routes have been plotted on the accompanying map, to indicate the main points of interest:

Route 1: Via Montgomery, Atlanta, Knoxville to Cincinnati. The famous Norris Dam, outranking even Muscle Shoals, can be visited from Knoxville by a short lay-over.

Route 2: Through Montgomery, Atlanta, Nashville and Chattanooga. Lookout Mountain and its historic battleground are near Chattanooga. Stop off at Mammoth Cave.

The French Market in New Orleans where the common folk gather after mass on a Sunday morning to gossip in all the tongues of the Western Hemisphere.

Route 3: Via Birmingham, Knoxville (Norris Dam), to Cincinnati.

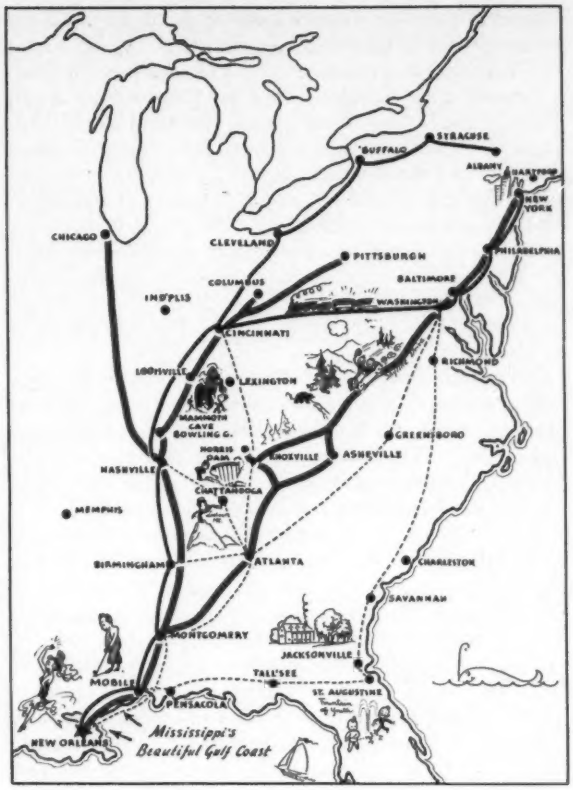
All tickets routed over the L. & N. from Cincinnati to New Orleans may be exchanged at New Orleans to enable the purchaser to return via any of the above routings.

Route 4: Via Montgomery, Atlanta, Charlotte, Washington, D. C., and Eastern points. Beautiful University of Virginia is located at Charlottesville.

Route 5: Via Jacksonville, Fla., thence northward over the Seaboard Air Line Railway through Savannah. St. Augustine, only a few miles from Jacksonville, lays claim to being the oldest city in America, and is outstandingly picturesque. Other Florida points can be reached by a side trip from Jacksonville.

If the trip to New Orleans is to be a success with special cars and all of the advantages that will accrue from such an arrangement, *it is important that each one get in touch immediately with the member of the Transportation Committee in his particular locality.*

Extensive plans have been made for the entertainment of the ceramists and their wives. The very first night, Sunday at the Hotel Roosevelt, there will be a party with lots of local talent and local color. This will be informal (no charge). Tuesday, there will be a dinner, a dance and entertainment. The President's Reception and the Orton Fellow Lecture will take place Wednesday night. These events combined with the natural gaiety of New Orleans signify a good time as well as a profitable time.



Glass Division Papers

The technical sessions of the Division will open with a paper by Prof. A. Silverman, of the University of Pittsburgh, "Annual Report on Glass." This will be rather in the nature of a prediction as to the means by which these annual reports will be assembled and the form which they will take. Such a report is lacking in our present periodical literature, and it is good news that we may be prepared to listen for it.

As a starting point for the approach of complete understanding of the physical properties of glass, Dr. H. R. Lillie, of Corning Glass Works, has chosen to present a detailed study of the Properties of Glassy Boron Oxide. As a member of the research staff of the company which has been most successful in the extended use of boron oxide in glasses, this author is in position to present exact details concerning the behavior of this very essential component of glass for technical purposes. Following this paper will be one by Prof. S. R. Scholes, of the New York State College of Ceramics, who will make some attempt to show what happens, chemically, to boron oxide as it enters soda-silica glasses. This paper, presented by a chemist in the presence of physicists, may properly be regarded as a cervical projection.

After making an X-ray diffraction study of soda-boron oxide glasses, Professor B. E. Warren and J. Biscoe of M. I. T. conclude that no discrete molecules of B_2O_3 are present. They will give interesting data on atomic arrangements, with no indications as to pus cavities.

Young and Finn, of the National Bureau of Standards, seem to have found some simple, two-component glasses that walk a straight line, and follow additive relationships between compositions and densities. It must be that the "three's a crowd" idea is valid here.

For some years, V. C. Swicker, of the Hartford-Empire Co., has been making ring sections of bottles and examining them under the polarizing microscope, making diagnoses which corroborate strength tests. We are fortunate in having this helpful method presented, and in the prospect of learning how to detect ring-worm, string-halt, incipient spavin, and other vial diseases.

Dr. Preston will release from his Butler hilltop laboratory an outline study course on mechanical properties of glassware. This is intended to give beginners an approach to the subject, especially as it relates to containers. This should be a masterly presentation by an expert who believes in testing things made of glass rather than testing glass itself.

As a continuation of the work reported by Taylor and Dear in 1937, Doran and Taylor, of Penn State, have worked on potash-silica glasses, in the temperature region where they yield a little, but still carry stresses. No excessive strain on the audience is anticipated.

Along a somewhat similar line are the series of experiments by Dr. Lillie, of Corning, who has kept glass canes bent under loads for ten weeks, finding that some curvature remained after the stress was released, although the temperatures employed did not rise above 383°C. (720°F.). Perhaps "infinite viscosity" is a term that needs qualifying. The canes straightened their "tired" backs somewhat after a while—more, if they were not too warm while carrying the load.

C. A. Bradley, of Corning, has been blowing bubbles, and thereby preparing to report on the applicability of the "maximum pressure at which a bubble is stable" (Parmelee) method to the estimation of viscosity. There will be nothing frothy about these measurements of vis-

cosities of molten glasses ranging from 50 to 2,500 poises, with a precision of one per cent.

"A Numerical Evaluation of the Constant in the Gladstone and Dale Equation" will be presented by A. N. Finn, of the Bureau of Standards. Many of us are hoping that we shall become informed concerning what this equation is before we are gently led into the necessary algebra and arithmetic. Two more papers of mathematical character follow. One is by Dr. Lillie, of Corning, who discusses the factors involved in stress release. Prof. Taylor will then indulge his propensities for the mathematics of physical chemistry in a quantitative treatment and molecular interpretation of the law of annealing of glass.

Many who have worked with colored glasses have observed that such glasses cool more rapidly than flint or crystal pieces. O. G. Burch, Owens-Illinois Company, has taken up this matter in a quantitative way, and devised a laboratory test to find out how much better radiators colored bottles are than their paler brethren.

Dr. W. Weyl, Penn State College, who has made a specialty of color phenomena, treats the subject of fluorescent glasses. This almost magical phenomenon of fluorescence is something that we all know just enough about to make us genuinely curious, and we look forward to this thorough treatment and scientific explanation by Dr. Weyl.

The relative solubility of glasses in acid solutions as indicated by dye absorptions is treated by Hamilton and Finn of the Bureau of Standards. The resistance of glass, especially bottle glass, to acid attack has long been recognized as dependent upon composition, but it has not been easy to devise methods for estimating the rate of attack. This contribution should be particularly interesting.

It will be recalled that, last year, the Glass Division went into partnership with the A.S.T.M., which recognized that glass, through its manifold structural applications, has reached the status of an engineering material, for which specific tests must be developed. Dr. G. W. Morey of the Geophysical Laboratory, as the chairman of Committee C-14, will summarize and report on the measurements that have been made on the behavior and performance of glass from this point of view. This work has a special significance because it involves cooperation, through arrangements made by the Commission of the International Congress, with our colleagues in England and in Europe. It should go far toward indicating how much reliance designers and engineers can place upon our material.

It is evident from this brief summary of the announcements and abstracts at hand that this program presents a wide variety of topics and treatment, ranging from the actual manufacturing processes to the highly theoretical and mathematical handling of our mysterious liquid. It offers real inducement for the attendance of every member who can make the trip to the Crescent City.

In addition to the technical papers which will be read at the sessions of the Division, there will be three addresses dealing with glass presented before the general sessions of the Society. The first of these will be by Slater and Thomas of the Owens-Illinois Glass Co. on "Fiber Glass." These men will discuss the methods of manufacturing staple and continuous fiber glass and applications of these fibers as an inorganic textile fabric. A motion picture film will be shown in connection with this talk.

Another public lecture is by G. M. Rapp of the Pittsburgh-Corning Corporation on "Structural Glass." Mr. Rapp will discuss this subject in its historical and general aspects, showing the fitness of glass for building purposes.

W. B. Jones of the Geological Survey of Alabama will describe the glass sands of his state. Mr. Jones will also treat the geology of some unfamiliar silica deposits.

The A.C.S. Transportation Committee

ALABAMA
University—Prof. T. N. McVay, University of Alabama

CALIFORNIA
Huntington Park—Thomas H. Curtis. Box 383

CONNECTICUT
Hartford—V. C. Swicker, Hartford-Empire Co.

ILLINOIS
Alton—E. W. Summers, Owens-Illinois Glass Co.
Chicago—G. G. Hanson, Colorado Feldspar Co.
Cicero—B. T. Sweeley, Chicago Vitrolite Enamel Products Co.

INDIANA
Anderson—Ralph E. Hanna, National Tile Co.
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Louisville—Robert G. Boyd, Standard Sanitary Mfg. Co.
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Detroit—Frank H. Riddle, Champion Spark Plug Co.
Grand Rapids—G. W. Dykstra, Kelvinator Corporation

MISSOURI
Mexico—Richard S. Bradley, A. P. Green Fire Brick Co.
St. Louis—J. C. Crawford, Walsh Refractories Co.

NEW JERSEY
Manville—Harold T. Coss, Johns-Manville Co.
New Brunswick—Prof. George H. Brown, Rutgers University
Perth Amboy—R. L. Clare, Federal Seaboard Terra Cotta Co.
Trenton—V. V. Kelsey, Consolidated Feldspar Corporation
Vineland—J. F. Green, Kimble Glass Co.

NEW YORK
Alfred—C. R. Amberg, Alfred University
Buffalo—Grant S. Diamond, Electro Refractories & Alloy Mfg. Co.
Corning—Dr. J. T. Littleton, Corning Glass Works
LeRoy—Grover W. Lapp, Lapp Insulator Co.
New York—John T. Ogden, THE GLASS INDUSTRY; Robert F. Sherwood, United Feldspar Corporation
Niagara Falls—W. V. Knowles, Titanium Alloy Mfg. Co.
Olean—Marvin H. Pond, Olean Tile Co.
Rochester—B. A. Rice, Pfaudler Co.
Schenectady—L. E. Barringer, General Electric Co.
Syracuse—F. P. Hall, Pass & Seymour Co.

NORTH CAROLINA
Raleigh—Prof. A. F. Greaves-Walker, North Carolina State College
Salisbury—John H. Isenhour, Isenhour Brick & Tile Co.
Spruce Pine—J. R. Grout, Jr., Harris Clay Co.

OHIO
Canton—B. T. Bonnot, The Bonnot Co.
Cincinnati—Thomas Arnold, Cambridge Tile Mfg. Co.
Cleveland—Robert Galbraith, E. I. du Pont de Nemours Co.
Columbus—Prof. J. L. Carruthers, Ohio State University
Dayton—H. W. Alexander, Frigidaire Div., General Motors
East Liverpool—J. W. Heppelwhite, Edwin M. Knowles China Co; Laurence H. Brown, Hall China Co.
Ironton—C. E. Bales, Ironton Fire Brick Co.
Sebring—V. J. Roehm, Sebring Pottery Co.
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New Castle—Wm. S. Emley, New Castle Refractories Co
Philadelphia—George C. Betz, Foote Mineral Co; E. G. Bourne, Gill Glass and Fixture Co; Frederick Stanger, Enterprise White Clay Co.
Pittsburgh—Ray E. Birch, Harbison Refractories Co; J. E. Eagle, Vitro Manufacturing Co.
Washington—Dr. R. R. Shively, B. F. Drakenfeldt Co.

WASHINGTON, D. C.—T. A. Kleinfelter and W. N. Harrison, Bureau of Standards

WEST VIRGINIA
Charleston—C. A. Walworth, Libbey-Owens-Ford Glass Co.
Chester—Richard Brian, Harshaw Chemical Co.
Kenova—Paul H. Sanborn, Jeffrey-DeWitt Insl. Co
Wheeling—R. W. MacDonald, Wheeling Tile Co.

WISCONSIN
Milwaukee—H. J. Held, Rundle Mfg. Co.

ABSTRACTS OF TECHNICAL PAPERS

GLASS DIVISION PAPERS

1. Annual Report on Glass. *By Alexander Silverman, University of Pittsburgh.*

Plans are under way for the preparation of comprehensive annual reports on glass, of which the first will cover the science and technology of glass as gathered from various publications such as technical and trade journals. An outline has already been submitted for a W.P.A. project. If this receives government approval, the plan will be carried through as expeditiously as possible. At present, the only annual report on glass which is available is the one which appears as a brief chapter in the Annual Reports of the Society of Chemical Industry of England, since the Annual Survey of American Chemistry, which was published by the National Research Council, has been discontinued.

2. Physical Properties of B_2O_3 Glass. *By H. R. Lillie, Corning Glass Works.*

A complete understanding of the physical properties of glass and their dependence upon its atomic arrangement is difficult to achieve owing to the complexity of the material. Boric-oxide glass may serve as a starting point in such an understanding. Properties reported at this time are viscosity; softening, annealing and strain points; expansion coefficient; electrical conductivity; density; index of refraction and dispersion; Young's modulus; birefringence constant; and surface tension.

3. Expansibility Factors for Boron Oxide Glasses. *By S. R. Scholes, New York State College of Ceramics at Alfred University.*

Boron oxide forms by itself a glass of high coefficient of thermal expansion. When added to soda-silica glasses in limited amounts, it effects a reduction in expansibility, but in larger amounts it increases expansibility. This anomaly is explained on the basis of the formation of sodium borates, which are less expansible than sodium silicates. Factors, applied to these compounds and to free B_2O_3 and SiO_2, are developed from the estimation of coefficients of expansion.

4. X-Ray Diffraction Study of Soda-Boric Oxide Glass. *By B. E. Warren and J. Biscoe, Massachusetts Institute of Technology.*

X-ray diffraction patterns have been made of three samples of soda-boric oxide glass having the following molal compositions: 0.114 Na_2O, 0.225 Na_2O, and 0.333 Na_2O. The patterns were made in an evacuated camera using MoKα radiation monochromated by reflection from rock salt. Radial distribution curves for the three compositions were obtained by Fourier analysis. The first peak is due to the boron-oxygen separation. The distances are 1.37, 1.42, and 1.48A. From the peak areas, the number of oxygens about a boron is found to be 3.18, 3.68, and 3.96. The continuous change in both interatomic distance and number of surrounding oxygens indicates a progressive change in boron-oxygen coördination. In B_2O_3 the coördination is predominantly triangular, each boron bonded to 3 oxygens. With increasing soda content, more of the borons become tetrahedrally surrounded by 4 oxygens. The second peak occurs at 2.40A and is due to oxygens about a sodium and oxygens about an oxygen. The area is well explained by assuming about 6 oxygens around a sodium and 5 to 6 oxygens about an oxygen. The results definitely exclude discrete B_2O_3 molecules.

5. Some Linear Relations Between Composition and Density of Binary Glasses. *By J. C. Young and A. N. Finn, National Bureau of Standards.*

Studies of density-composition relations of soda-silica, potash-silica, and lithia-silica glasses indicate the relations should be represented by intersecting straight lines. Previously reported data have been reviewed and additional data, based on new glasses, have been added to those previously reported. Thermal expansion-composition data also show similar linear relations.

6. On the Measurement of the Surface Tension of Viscous Liquids. *By C. A. Bradley, Corning Glass Works.*

The surface tensions of liquids of widely differing viscosities have been measured by the maximum bubble-pressure method. With liquids whose viscosities are greater than about five poises, modification in technique is employed which consists in observing the maximum pressure at which a bubble is stable. This is the same technique as employed by Parmelee. The applicability of this method for viscous liquids has been tested by measuring the surface tension at 25°C of a series of solution of rosin in benzyl-benzoate whose viscosities varied from 100 to 2500 poises. The values obtained were within 1 per cent of those observed by the method of capillary rise. The method has been applied to the measurement of the surface tensions of molten glasses whose viscosities varied from 50 to 2500 poises. The precision obtained is about 1 per cent.

7. Law of Annealing of Glass — Quantitative Treatment and Molecular Interpretation. *By Nelson W. Taylor, Pennsylvania State College.*

The reduction of strain birefringence with time in Pyrex-brand chemical resistance glass has been shown to follow the equation,

$$\delta = \delta_m + \delta_{aw}$$

Where δ_m = that part of strain released according to Maxwell's stress law, $-df/dt = k_1 f$.

δ_{aw} = that part released according to the Adams-Williamson law, $-df/dt = k_2 f^2$.

$$\delta_m = \delta_{m0}\, e^{-kt}.$$

$$\delta_{aw} = \delta_{aw0}/(1 + \delta_{aw0} At).$$

The molecular nature of stress and strain has been examined, and it has been shown that the Maxwell law is followed when the stress-bearing molecular species (principally the dissociated units) relax independently, without interaction, the Adams-Williamson law is followed when these same species relax by virtue of interaction according to the well-known law for a second order or bimolecular reaction, $-dx/dt = k_2 x^2$. The temperature dependence of each of these two processes is discussed,

and an activation energy of 94,000 calories is calculated for the bimolecular interaction process. The theory as outlined appears to be a necessary and sufficient description of the annealing process in silicate glasses or similar materials.

8. A Discussion of Factors Involved in Stress Release. *By H. R. Lillie, Corning Glass Works.*

An attempt is made to clarify the interpretation of factors involved in the release of stress in glass. Concepts adopted by various authors are seldom at variance with one another; rather, they represent different aproaches to the problem and appear as proof of progress when the proper significance is attached to each factor.

9. The Effect of Glass Color on the Setting Rates of Glass in the Manufacture of Glass Bottles. *By O. G. Burch, Owens-Illinois Glass Co.*

It has been observed in the manufacture of bottles of the same size and shape from various colored glasses, such as emerald green and amber, and from the so-called flint bottle glass, that higher machine speeds are usually obtained in the case of the colored glasses. A laboratory test has been devised to measure the cooling rates of several colored and colorless glasses throughout their respective working ranges, which gives results paralleling the speeds obtained in actual bottle manufacture.

10. Fluorescent Glasses. *By Woldemar Weyl, Pennsylvania State College.*

The theory of fluorescence is briefly discussed. Many ions which do not show fluorescence in aqueous solutions do so in glass. This phenomenon can be explained by the smaller perturbation fields in the high viscous glasses. Decreasing the perturbation increases the probability of fluorescence. On the basis of energetically isolated atoms and molecules some fluorescence-phenomena can be explained and new fluorescent substances can be produced. The value of fluorescent glasses for illuminating glass ware will be discussed.

11. A Numerical Evaluation of the Constant in the Gladstone and Dale Equation. *By A. N. Finn, National Bureau of Standards.*

Consideration of the specific refractivities (R) of the glass-forming oxides indicates that R can be expressed, empirically, in terms of ionic radii and hydrogen equivalent-weights of the oxides. In these relations, the oxides fall into two groups, one of which has twice the effect of the other, and from these the constant of the Gladstone and Dale equation can be estimated for each oxide from its molecular weight and atomic radius.

12. Elastico-Viscous Properties of Certain Potash-Silica Glasses. *By Robert Doran and Nelson W. Taylor, Pennsylvania State College.*

This work is being carried along the same lines as that on soda-silica glasses by N. W. Taylor and P. S. Dear, *Jour. Amer. Ceram. Soc.*, 20, 296-304 (1937). Comparison will be made of the two glass types.

13. Permanent Bend in Glass Canes. *By H. R. Lillie, Corning Glass Works.*

An account is given of canes of glass, of known thermal history, treated under high bending stress for ten weeks at temperatures from 73° to 383°C. The percentage of stress released during the period is computed from a measurement of the curvature remaining after stress removal. The amount of stress release depends upon the kind of glass, the previous thermal history, and the temperature of treatment under stress. During an extended period after stress removal, the curvature is observed to decrease, this decrease being most pronounced in the canes treated at the lowest temperature. Comparisons are made between stress release under these conditions with release observed optically in samples chilled in the ordinary way.

14. Ring Section Examination of Glass Containers. *By V. C. Swicker, Hartford-Empire Co.*

Regular periodic examination of cross-sections of glass containers with the polarizing microscope has proved to be a most valuable adjunct to recognized strength tests. The method is described, and its usefulness in the prediction of ware serviceability and as a means of glass quality control, is explained.

15. Relative Solubility of Glass in Acid Solutions as Indicated by Dye Absorption. *By E. H. Hamilton and A. N. Finn, National Bureau of Standards.*

Recent studies on the rate of solution of glass in acid and alkaline solutions have indicated that relative "chemical durability" of glasses could be estimated by the amount of dye adsorbed on treated glass surfaces. The chemical durability is proportional to the amount of "Victoria blue" adsorbed by a glass surface which has buffered at p_H 6. Dyed samples of different glasses will been treated with a solution of potassium acid phthalate be shown.

16. Outline Study Course on Mechanical Properties of Glassware, with Particular Reference to Glass Containers. *By F. W. Preston.*

A series of eighteen brief memoranda in the methods of approach to this subject, with some discussion of the phenomena involved, is presented. This is intended as an outline for beginners and not as a summary of all that is known to date on the subject.

17. Report on Committee C-14 of the A.S.T.M. *By G. W. Morey, Geophysical Laboratory.*

REFRACTORIES AND OTHER PAPERS OF INTEREST

Some Properties of Air-Setting Refractory Mortars (Wet Type). *By R. A. Heindl, National Bureau of Standards.*

Twenty mortars of the type marketed in the wet condition were subjected to various tests for purposes of obtaining data which could be incorporated in a Federal Specification for this commodity. After having been in storage for some months, it was noted whether the solids in the mortars had separated from the liquid, whether the solids and liquid could be readily recombined and whether or not the mortar had a satisfactory working consistency. The water-loss at 105°C, alkali content, sieve analysis, pyrometric cone equivalent, and setting time were determined. A machine was developed to simulate mechan-

(*Continued on page* 106)

MUFFLE-TYPE LEHR FOR SHEET GLASS ANNEALING

Installation at the St. Paul glass plant of the Ford Motor Company represents an outstanding application of this type of design.

Operation of a new muffle-type continuous lehr at the Twin Cities Branch of the Ford Motor Co. was begun last June. It was designed by the Amsler-Morton Company of Pittsburgh and erected by Ford, under Amsler-Morton supervision, during the spring of 1937. The installation met with early success and is winning regard as an almost fuel-less furnace.

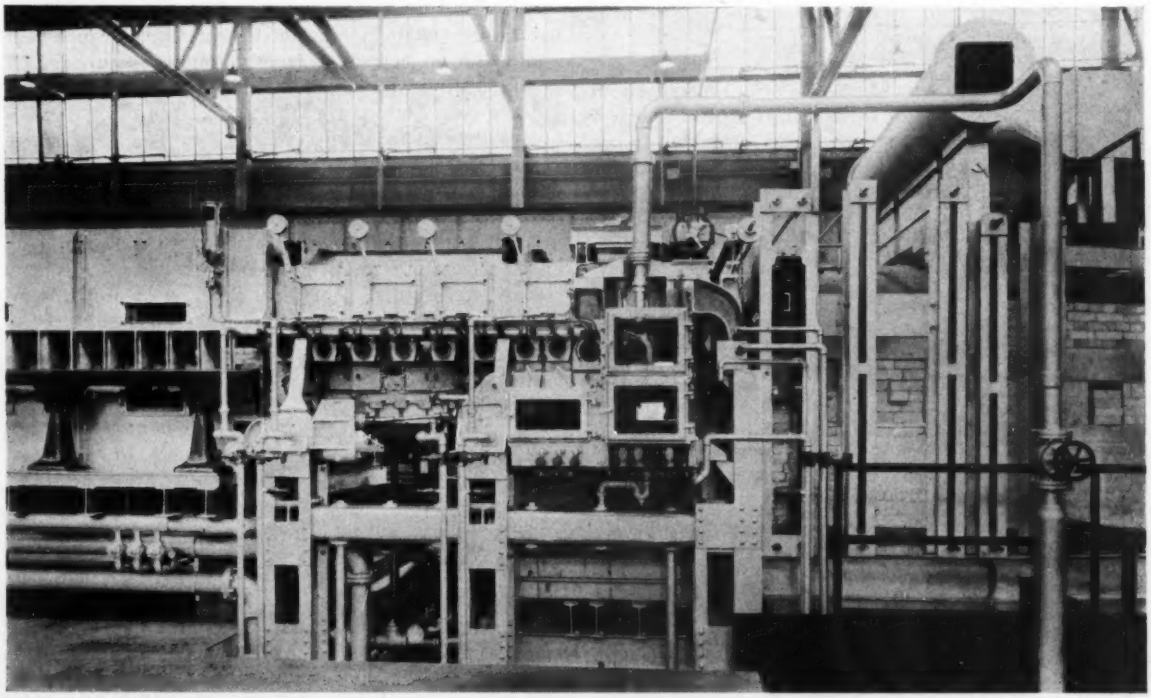
In the new lehr, the sensible heat in the glass is conserved to such a degree that annealing is accomplished with the use of very little fuel. Although the Amsler-Morton design provided burners for seven sections, covering the major portion of the lehr, current practice requires their use on only the first section. A pilot light is kept burning in the second section, but even this precaution is found unnecessary on the remaining sections of the lehr.

The lehr, a steel inclosed structure resting on a concrete and steel substructure, is 175½ ft. long, with an inside width of 126 in. and an over-all width of 12 ft. 9 in. There are seven heating or regulating zones, from 20 to 22 ft. in length, followed by a hatch-cover section at the discharge end. The height of the enclosing structure is 6 ft. 4 in., but the base of the structure itself is nearly four feet above ground level and the glass travels, therefore, at a height of about seven feet above ground level.

From the roof of the muffle chamber up to the bottom of the lehr rollers, the distance is about 11 in. The rollers add another 6⅛ in., and from the top of the rollers to the under side of the main roof is another 12 in. Concrete blocks 18 in. square form the base for the installation, their height being varied to eliminate the influence of irregular ground level. They support 16-in. longitudinal beams and these, in turn, support 8-in. cross beams, spaced on 2-ft. centers. The steel shell of the lehr rests directly on these cross beams. The beams also support the channel bases of the cast-iron legs and the brackets which bear the roller ends and carry the driving machinery on the east side of the lehr. The cast-iron legs are five to six feet apart and, together with the brackets, were reclaimed from the old annealing lehr. The brackets have been milled out to provide space for clean-out holes. A steel catwalk is also supported on the west side to permit observation and maintenance.

There are 28 clean-out holes on each side of the lehr to permit removal of glass fragments. These clean-out holes, when not in use, are covered with a metal frame and are well insulated. They have sloping sills, the outside dimensions being about 20 x 10 in., and the inner opening about 20 x 6 in. The lehr transports the glass on 134 rollers, with four additional rollers on the discharge end. These rollers are of steel tubing, asbestos covered, with a full diameter of 6⅛ in. They are made as compact as possible and are ground smooth to protect the traversing sheet. Since operations began, only two of the rollers have required removal.

Photos courtesy of Ford Motor Company.



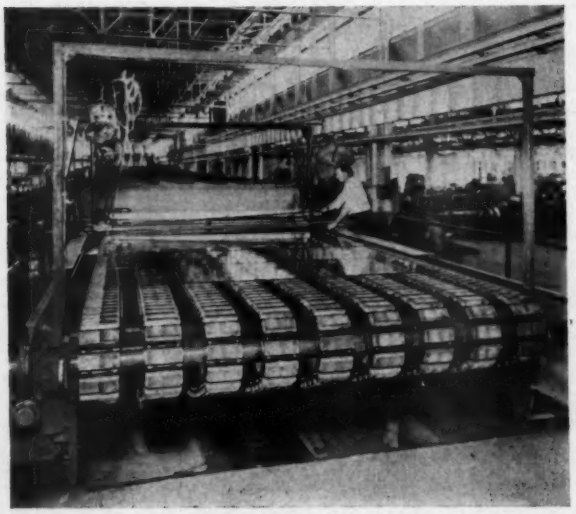
The left side of the glass machine, showing how it joins the annealing lehr. The end housings of the drawing machine rolls are visible. The glass windows in the center of the picture permit observation of the sheet as it is drawn.

The discharge end of the continuous sheet glass annealing lehr at the Twin Cities branch of the Ford Motor Co. The capping table permits edge trimming and multiple cutting, and facilitates disposal of the sheet multiples.

Either of two 15-hp. direct-current motors, located on the right side of the lehr looking from the tank, furnishes the motive power for the lehr rollers and the glass drawing machine. The power is transmitted to a long shaft which drives one end of each of the rollers through worm gears. The motors are connected with a rheostat control and if one motor fails, for reasons other than power shut-off, the other cuts in automatically. Oil is pumped through the driving mechanism, and the gears turn in oil.

A Ford Motor application of the P.I.V. drive controls the differential in speed between the glass drawing machine and the lehr. A somewhat faster speed is employed for the lehr rollers in order to exert some tension on the sheet and minimize buckling and distortion. The speeds are recorded by an electric tachometer and an increase of about five per cent is usually used for the lehr rollers.

The floor of the glass chamber, which is also the roof of the muffle section, is of carbo-refractory tile and rests on firebrick piers, four inches square. The piers rest on a floor of firebrick, two thick at the hot end and one thick at the cold end. Below this is a solid section of sil-o-cel, resting on a paving of hollow building blocks. The muffle chambers extend between the firebrick piers, and have a free height of 5½ in. They connect the burners at the front of each section to the waste gas flue openings at the end of each section.



Another view of the capping table at the discharge end.

From the roll level to the muffle roof the side walls are made of firebrick, one thick, backed up by sil-o-cel. Vermiculite blocks are used as a boundary material for openings, such as the clean-out holes on each side. Below the muffle roof level, only sil-o-cel is used for the side walls. To prevent heat losses rock wool is used for packing all joints, near all bolts, and near openings.

The roof plate is supported by backed-up channels, with bolts extending through the roof structure. Heat resisting alloy is used for the metal material in the first 67 ft. of lehr length and steel is used for the balance of the lehr. The roof structure, from top down, consists of the metal assembly, a layer of cement plaster, a varied thickness of sil-o-cel, and a bottom row of vermiculite blocks resting on metal plates.

For the first 67 ft. of the lehr length, a 6-in. thickness of sil-o-cel is used in the roof structure. A 4-in. sil-o-cel body is employed for the next 26 ft. 8 in., the thickness of this insulating material being decreased to 3 in. for the next 26 ft. 8 in., and finally to 2 in. for the last 26 ft. 8 in. section of roof.

The lehr is set tandem to a glass-drawing machine, which draws from a pool of molten glass in a gas-fired 50-ton melting furnace. The glass is produced to a gauge of .087/.095 in., the standard limits for single-sheet drawn window glass; but limits of .090/.095 in. are actually observed. The lamination or sandwich pairing is performed in other Ford Motor plants, and the practice has been described in a recent issue of THE GLASS INDUSTRY. Important factors governing the gauge are temperature and rate of draw, but since an effort is made to maintain a constant temperature, the practical application of control is largely confined to regulation of the drawing speed. As a rule, this drawing speed is approximately 60 in. a minute so that the 175½ ft. lehr operates on an annealing cycle of less than 40 minutes.

Whereas rolled plate glasses tend to a higher content of soda, a richer lime content is desirable for drawn sheet glass. The viscosity range of glasses rich in lime is short and, although such glasses are more fluid at high temperatures than high soda glasses, they stiffen rapidly on chilling. A typical analysis of Ford Motor drawn sheet window glass, as produced at the Twin Cities Branch, is as follows:

SiO_2	72.0 per cent
Fe_2O_3	.1 " "
Al_2O_3	.6 " "
CaO	10.1 " "
MgO	4.2 " "
Na_2O	13.0 " "

The silica sand used in glass manufacture at this plant is mined directly beneath the factory site, at a depth of about 100 feet below the surface.

The sheet is drawn vertically from a molten pool, the temperature of which is about 2050 degrees F., and in traversing 28 in. to the bending roll, it is calculated to lose about 250 degrees. A further loss in heat as the sheet is directed to horizontal travel reduces the tem-

perature to about 1400 degrees, and the glass finally enters the annealing lehr at about 1200 degrees F. This initial loss of temperature occurs while the sheet travels a horizontal distance of about 12 ft. through the glass machine, and as it traverses the bending rolls, idling rolls and eight machine rolls. The sensible heat remaining in the glass is then largely conserved in the annealing lehr.

A measure of temperature was originally provided by 21 thermocouples located in the muffle chamber below the annealing floor of the lehr. Three of these were located in each section and corresponded to the edges and the middle of the traveling sheet. The temperature recorded by these couples was lower than the actual temperature of the glass sheet, but related to it. To obtain a closer association with the glass temperature, and to avoid any lag effects, the Ford Motor engineers added 27 thermocouples in the glass chamber of the lehr, with their points close to the glass sheet. Only 19 of these couples are in continual use and a schedule of permissible temperature ranges has been worked out for these 19 thermocouple locations. This schedule follows:

	In Degrees Fahrenheit	
Couple	*Max. Temp.*	*Min. Temp.*
1	1140	1120
2	1135	1110
3	1145	1115
4	1140	1115
5	1130	1105
6	1110	1090
7	1070	1050
8	1080	1065
9	1060	1045
10	1000	980
11	1010	990
14	965	950
17	855	845
20	760	745
21	760	745
22	600	590
23	610	600
26	535	520
27	525	515

The first six couples cover the first section of the lehr, measuring both edges and the middle, near the front of the section, and again near the end of the first section. Couples 7, 8, and 9 are in the second section, while 10 and 11 are near the beginning of the third section. Some allowance for a variation from edge to edge may be noted, and this variation is controlled to guide the influence of cooling on the metal's straightness.

From a temperature of slightly over 500 degrees F., in the seventh section, the metal drops to about 180 degrees at the outlet end of the lehr. Thus, the major portion of the 1,000-degree temperature drop occurs in a relatively small part of the lehr. This drop is facilitated at the end of the cycle by the use of hatch covers on the last 30 ft. of the lehr, and these may be opened as required. On the other hand, it is important to conserve the heat in the high temperature section to permit slow cooling through the critical.

Some difficulty was originally experienced in providing the desired gradient, so insulation was added at the

Looking up from underneath. The sheet is passing over the last several rollers before discharge from the lehr.

hot end, and baffles were constructed within the lehr to prevent convection currents. The first set of these baffles is near the lehr entrance, another set is about 80 ft. away and the last set is about 120 ft. from the hot end.

The first baffle includes brick in its construction, while the others are made of sheet steel. The top half of each set swings from the roof to a point just above the glass sheet, the provision for movement preventing jams by buckled sheet or chunks of devitrified glass. The bottom baffle extends from the floor, or roof of the muffle chamber, to a point between a set of rollers.

Attempts to dispense with added heat on the first section have been made, but there is a hazard of glass breakage from too rapid chilling. It has been set up as standard practice, therefore, to employ three atmospheric gas burners on the first section and to keep the pilot light burning on the second section as a precautionary measure. In the event of a temperature drop the

Overhead view of the annealing lehr, designed by the Amsler-Morton Co. Roof construction, temperature control panel to the left of the lehr, and electric tachometer to the right may be noted. The motors and driving mechanism for the rollers are on this side of the lehr.

controls automatically ignite the second-section burners from the pilot light.

Another refinement was added in the mechanism for heat control. One valve, a 2-in. Honeywell control, originally regulated all three burners for a given section. This valve has been eliminated and replaced by three individual ¾-in. valves, providing separate control for each burner. Since the burners connect with separate muffle chambers which lead to separate flues, complete control of either thermal input or cooling is provided for each section, and for either edge or the middle of each section.

The disposal of the sheet product is facilitated by a capping table at the outlet end of the lehr. It was built by the Ford Motor Company, and is a rotating conveyor of caterpillar design, with felt pads on wooden blocks bearing the sheet. A special Ford cutting mechanism can be clamped to the traveling sheet, and edge trimming as well as multiple cutting is simply performed. Mercury lamps provide illumination for a preliminary inspection of the glass product.

NEW TECHNICAL BUILDING FOR L.-O.-F. APPROACHES COMPLETION

A new technical building which is the culmination of nearly three years of careful planning, design and construction will soon be completed at the East Broadway plant of the Libbey-Owens-Ford Glass Co., in Toledo. It will house the general engineering and research staffs of the company and presents many exceptional features in a well-coordinated plan. Unlike many new glass plant buildings of recent years, no attempt has been made to use architectural glass products except for decorative purposes.

The potency of glass as a decorative material in industrial buildings is exhibited by the use of colored Vitrolite around the entrance, in the lobby and in a belt extending across the facade of the building. The colors at the entrance are black and red with tan and red on the facade. Otherwise the wall construction is of brick and tile, most of the inside walls being faced with glazed block. Office partitions are of the usual steel and glass construction.

The building is U-shaped, one story in height, and consists of a main section at the front facing East Broadway and two wings extending toward the rear at each end of the main section. A basement is provided beneath the right-hand, or south, half of the main section and part of its wing. The floor at the rear end of this wing is located at ground level, 3½ feet below the level of the main floor, in order to provide support for the heavier machinery and equipment. There are thus three floor levels in the building, the main floor, the ground floor in the rear section of the south wing, and the basement level 12 feet below the main floor.

The main section of the building is 245 ft. long, the south half having a depth of 49 ft. and the north half of 43 feet. The entrance lobby is located in the center. The north wing extends back 80 ft. from the main section and has a width of about 42 feet. That section of the south wing at main floor level extends back 52 ft. from the main building and has the same width as the other wing. The ground level portion of the south wing is about 82 ft. square.

A corridor extends through the center of the main building, giving access to the private offices which are located along the entire front. The north wing is given over entirely to the engineering drafting room and this half of the main section is also occupied by the engineering department. In addition to the private offices it provides space for the engineering vault, library and conference rooms.

The south half of the entire building will be occupied by the general research department offices and laboratories. The organic research and analytical laboratories are situated back of the main corridor and a library and conference room are also provided. The main floor wing at this end houses the physical laboratory, a calorimeter room and the entrance space from the loading platform. A freight elevator here serves the three floor levels of the building.

The ground-floor section of the south wing provides space for a variety of experimental research equipment and includes rooms for the machine shop, furnace and mixing, cutting and grinding, adhesives, high-temperature experiments, plastics, presses, autoclaves and storage.

With considerable foresight, a large area of the basement has been left unassigned to be available for at present unforeseen requirements. Other basement facilities include a dark room and record vaults, together with rooms for drop test, refrigerating machine, plastic research, spectograph, ultra-violet and cold tests. All of the necessary laboratory services for compressed air, electricity, water and gas are supplied on both floors.

The general layout of this fine new home for the Libbey-Owens-Ford technical and engineering staff is the result of careful planning by the organization under the direction of D. H. Goodwillie, executive vice president. The building was designed by Mills, Rhines, Bellman and Nordhoff, Inc., engineers and architects of Toledo, and is being constructed by A. Bentley & Sons Co., building contractors, also of Toledo. O. H. Paddock, of the Specialties and Development Dept. of Libbey-Owens-Ford, supervised the design and construction work.

PLASTICS TRAVELCADE WILL BE SHOWN IN RADIO CITY DURING MARCH

The story of the modern plastics industry and the number of industries which it serves will be shown in the Bakelite Travelcade at Rockefeller Center, New York, from March 1st to 31st, inclusive. The growth of the industry is entertainingly presented by a series of animated and dramatic exhibits indicating where plastics play a part in modern living. Among them are the uses of plastics in aviation, household appliances, building, business machines, abrasives, home furnishings, photography and optics, packaging, radio, machinery, fashions, automobiles, paints and varnishes, communications, amusements, music and the health of humanity.

When the Travelcade leaves Radio City, it will start on a city-to-city tour for a period of two months in New Jersey. After that it will be installed for the remainder of the year in the Franklin Institute, Philadelphia.

• The Inland Glass Works, Inc., Chicago, are planning an extensive expansion program including new tanks, lehrs, etc. The company manufactures a wide variety of glassware, lighting fixtures, specialties, cooking utensils and other heat-resisting ware.

THE FLUORESCENCE OF GLASS

By P. GILARD, L. DUBRUL, F. JAMAR, and D. CRESPIN

The fluorescence of glass is still quite poorly understood, if an exception is made of that caused by the oxides of praesodymium, neodymium, and uranium.

Lommel[1] has shown that the fluorescence of glasses with praesodymium and neodymium gives four maxima at 6500-6100, 5550-5000, 4850-4700, and 4550-4300 A°, the red glow only being due to the praesodymium and neodymium, and the green glow coming from the glass.

Likewise, Nichols and Merritt[2] published the spectrum of the fluorescence of a glass with uranium, with a maximum at 5240 A°, and Geiger[3] has shown that this maximum persists when it is heated up to 150°, but with a loss of intensity.

The action of the other constituents of glass is scarcely known. In 1931, Lester[4] published some information relating to colored glasses whose exact composition was not given. The only conclusions that can be drawn are these: the oxides of iron, of chromium, and of cobalt do not cause any fluorescence; the oxides of manganese, of copper, and of uranium give a green glow, cerium a violet and cadmium sulphide an orange tint. It is likely that the sulphur and the sulphides cause an orange fluorescence, but that cannot be definitely affirmed, the coloring matter of the glasses examined not being known; and finally, glasses decolored with selenium are not fluorescent.

Eckert and Schmidt[5] examined a series of glasses with cerium whose percentage varied from 0.005 to 10.24 per cent Ce_2O_3. They reported a blue fluorescence which reaches a maximum at 0.64 per cent Ce_2O_3, then decreases and finally becomes a yellowish green. The presence of TiO_2 seems to inhibit fluorescence.

Finally, Hofler and Dietzel[6] have been able to show that glasses colored pink by elementary selenium are fluorescent, while those which are colored brown by compounds of selenium do not give out any light to speak of.

The meagerness of this information has induced us to undertake a study of the question. Although it is far from being finished, we believe it would be useful to publish our first results immediately.

We have submitted numerous samples of glass, coming for the most part from experimental melts, and whose composition we knew, to the radiation of a 400 watt mercury vapor lamp enclosed in fused silica. An intervening Wood screen allowed only the ultra-violet rays and a few violet rays to pass through.

In order to appreciate the influence of the principal components, we examined first glasses not containing any secondary elements, except, of course, a little iron oxide which is not troublesome, since it does not introduce any fluorescence.

The pure soda silicates do not give any glow, nor do the lime-soda glasses, the magnesium-soda glasses, the barium-soda glasses, the oxide of zinc soda glasses, and the alumina-soda glasses. However, the calcium sodium glasses melted with Na_2SO_4 have a slight yellowish or greenish yellow fluorescence.

The potassium glasses with BaO and MgO have not shown, as yet, any fluorescence.

On the other hand, pale green or yellow glows have been observed with the lime and zinc potassium glasses.

The influence of the alumina in the potassium glasses seems quite strong; here are the results observed on two glasses:

Sand	*Calcium*	*Hydrate*	*Hydrate*	*Fluorescence*
100	15	5	48	yellow
100	10	10	48	intense blue

Lead oxide has shown quite intense shades of yellow-salmon pink in the sodium and potassium glasses melted in rather reducing conditions; a zone where reduction is indicated by a gray coloring, gives fluorescence in deep violet. On the other hand, industrial glasses melted from batch containing an important quantity of nitrate, show a bright violet-blue.

The role of boric anhydride seems quite important. Some quite strong fluorescence is obtained with the glasses containing B_2O_3, or with K_2O, or with CaO and Na_2O or K_2O or with BaO and Na_2O. The color is slightly variable:

Components	*Fluorescence*
SiO_2-K_2O	yellow
SiO_2-K_2O-CaO	yellow to greenish yellow
SiO_2-Na_2O-CaO	yellow
SiO_2-Na_2O-BaO	bluish (a little B_2O_3) to green-yellow (a great deal of B_2O_3)

The non-coloring secondary elements are not very active. A pale green glow appears in the soda-calcium glasses when As_2O_3, Sb_2O_3, or SnO is added to them. We have not been able to determine yet whether sodium-chloride, fluorine, cryolite, thorium oxide, and calcium phosphate act the same, but it seems that they do not.

We can only corroborate the information of Lester, concerning the decolorizers; the glasses decolorized with selenium are not fluorescent, while those decolorized with manganese give forth a very characteristic bright green glow.

The effect of the coloring matters is very varied and sometimes extremely curious. As Lester pointed out, chromium oxides and iron oxides are inactive, and as far as they are concerned, it is not important whether the melting conditions are oxidizing or reducing. On the other hand, we have proved that glasses with cobalt have a slight mauve fluorescence very distinct from their usual tint. Glasses with nickel are not fluorescent.

Glasses with manganese glow with a bright green light when their own coloring is weak, but when in the presence of intense violet color, fluorescence can generally no longer be distinguished (in one case only we have observed very dark green and mauve). We might won-

[1]Wied. Ann. 24, 1885, pp. 288-291.
[2]Phys. Rev. 19, 1904, pp. 18-36.
[3]Abh. Naturf. des Nurnberg. 16, 1906, pp. 1-8.
[4]Glass Ind. 12, 1931, p. 83.
[5]Glastechn. Ber. 10, 1932, pp. 80-85.
[6]Glastechn. Ber. 14, 1936, pp. 421-431.

Preliminary memorandum from the Glass Works' Experimental Laboratory of Val-Saint-Lambert, published in *Verres et Silicates Industriels* 1, 5, 1938. Translated by F. W. Preston and reprinted through the courtesy of the publishers.

der whether the oxidizing or reducing melting conditions do not have some influence, but it seems that they do not; the degree of coloring seems to be the only factor.

We shall not discuss glasses with uranium whose very strong yellow-green fluorescence is well known, nor glasses with praesodymium and neodymium which glow with a pink or mauve color. These effects have been known for a long time.

Our observations of glasses with cerium agree very well with Eckert's and Schmidt's. A glass with 0.5 per cent Ce_2O_3 gives an extremely strong violet blue fluorescence whose intensity diminishes a little at 5 per cent and very greatly at 7 per cent. This latter glass takes on a milky appearance; we note that it contains one per cent of TiO_2.

Ruby glass made with gold is not generally fluorescent; it happens, however, that the surface is yellow-brown; the shade and intensity vary a great deal, doubtless according to the conditions of cooling.

The cuprous oxide gives a very typical dirty green, easy to distinguish from the green-yellow of uranium and from the bright green of manganese, and with a relatively weak intensity. The copper rubies do not generally show any fluorescence (likewise the metallic copper), but if the surface has been rapidly cooled, it is violently colored a more or less greenish yellow; the same observation can sometimes be made along certain striae; the phenomenon appears intimately connected with the development of color and places the heterogeneities of substance remarkably in relief. In glasses flashed with copper a faint red glow is sometimes distinguished, but this is not always the case; specimens colored yellow after annealing under oxidizing conditions. where we suspected the existence of copper compounds, fluoresce with a yellow color.

The hypothesis that the yellow-green glow of copper rubies, in the parts where the color is not developed, is due to copper oxide, may therefore be considered.

We have also examined some glasses where the sulphur was introduced in the form of sulphides. We give below the results of our observations.

Compounds Added	*Color of the Glass*	*Color of Fluorescence*
3% CdS	very intense brown-red	none
3% CdS	intense brown-orange	non-fluorescent but orange traces
3.6% CdS	yellow	orange
1.5% CdS	colorless	none
1% $CuSO_4$+ 0.25% Al	pale yellow, traces of brown	orange, traces of non-fluorescent color
4.5% Sb_2S_3 0.75% S+	bright yellow	none
4.5% Sb_2S_3	bright yellow	doubtful
0.5% ZnS	yellow	quite pale brown
1.5% ZnS	brownish-yellow	quite pale brown
3% ZnS	intense brown	doubtful

The manner of introducing the sulphur seems to play a role by itself.

It seems that glasses containing sulphur should also deserve a complete study. The results obtained from glasses where elementary sulphur had been added to an ordinary composition, very poor in iron, still seem to indicate the existence of a relation between the color proper and the color of fluorescence, but we do not wish to begin this subject before a more thorough study. The tints observed range from yellow to orange and brown, and sometimes their glow is not distinguished.

Glasses containing selenium, the "rosalines," give a very clear pink or salmon fluorescence, visible when the addition of ZnSeO reaches 0.1 per cent. The presence of MnO does not modify the tint as long as the ratio MnO_2:$ZnSeO_3$ does not exceed 3:1. On the other hand, when the selenium is reduced to a metallic state, and if the conditions are slightly reducing, in such a way that the shade of the glass turns to brown, fluorescence is no longer distinguishable, at least with certainty.

In glasses containing selenium and cadmium sulphide, some remarkable phenomena also occur. The color of the fluorescence varies with the color of the glass.

Color of the Glass	*Color of Fluorescence*
yellow	yellow
yellow-orange	orange
orange	red
red	faint red
ruby	the same
opalized ruby	none

It is very likely that the reds and rubies fluoresce principally in the infra-red and the opalized rubies only in the infra-red.

The relation between the color of the glass and the fluorescence generally causes in rubies manufactured in industry a red fluorescence or even infra-red on fractured surfaces, while surfaces cooled with air or even by contact with the mold, during manufacture, glow yellow or orange.

It is a phenomenon analogous to that which we have pointed out in the copper or gold rubies, but the tint of the glow is absolutely different: greenish-yellow in the glasses with copper, brown in those with gold, and yellow-gold or orange in those with Se-CdS.

Heterogeneities of the glass are likewise evidenced by much more conspicuous differences of fluorescence than the differences of color in ordinary light.

Glasses flashed with silver are distinguished by a white or very characteristic yellowish fluorescence. It seems that it is excited by the near ultra-violet or by the violet, for it is still very clearly evident when a small plate. 5 mm. thick, is exposed in such a manner that the ultra-violet radiation must go through the whole thickness before reaching the flashed face. This peculiarity is also noticed in glasses flashed with copper and colored yellow at the first cooling.

We shall content ourselves with these few observations temporarily and wait for new studies in order to derive from them more extensive conclusions.

For the time being, we shall confine ourselves to a few remarks.

Fluorescence makes it possible to distinguish glasses decolorized with selenium from those decolorized with manganese, and to prove the presence of lead. It does not seem to us that it should give a positive criterion for glasses with boron and with alumina.

Among colored glasses, fluorescence can indicate the existence of various coloring matters, but it would be difficult, no doubt, to give exact rules to this subject. It

(*Continued on page ~~106~~ 102*)

GLASS NEWS FROM ABROAD

Austria—Various Austrian municipalities have extensive building plans for the year and the demand for window glass, which improved last year by about one per cent, is expected to increase another four per cent. Other branches of the industry also show improvement.

Belgium—The economic position of the Belgian glass industry has been decidedly improved by the 14 days stoppage of work the beginning of January. The industry is still complaining of high taxation and the indirect cost of recent social measures, which make effective competition on foreign markets difficult, but the outlook is not considered unfavorable. Last year, even when the difficult conditions of the last quarter are taken into account, there was a certain hardening of prices, which appears likely to continue.

Belgian industrialists have appointed a technical committee to help organize the display at the New York World's Fair and the Directeur-General of the Cristelleries du Val Saint-Lambert will represent the glass industry on this body.

Britain—On Feb. 1st Messrs. Pilkington Bros., Ltd., of St. Helens, introduced their family allowances scheme. Under this all their employees who have families of more than three children will receive grants of five shillings a week for every additional child.

Czechoslovakia—The situation in the Czech industry is rather uncertain. Markets have been brisk almost to the end of the year in spite of setbacks in foreign production centers, and during the last quarter. Production was about 30 per cent higher than in 1936 and this activity led to the reopening of many glassworks which had been closed during the depression. Then in December came a sudden drop in orders, and employment fell off. The latest news is that two more works have been reopened. The trade treaty with the United States should help the export of fancy ware and so offset the recent setback, which has been mainly felt on overseas orders.

Germany— Three new types of product are of growing importance to the German industry. Fancy ware, hitherto made exclusively from blown glass, is now being shaped into solid forms from the semi-molten state. The greater strength of the solid glass means that new shapes are possible and when the men have fully mastered the new technique, high class goods should be produced. The second interesting development is the use of unbreakable glass for a wide range of products. Vacuum flasks are quite generally made of this and all sorts of kitchen ware is, too. But it is the possibilities of fibre glass, or Glaswolle, as it is called here, which really excite German technicians.

Japan—The new factory at Mukden of the Iwaki Glass Co. has been completed and operation is scheduled to commence as soon as the branch has been reorganized into a Manchukuo corporation in connection with Japan's formal surrender of extraterritorial rights in the empire. Iwaki Glass is the foremost producer of special glass in Japan, and is a joint enterprise of American interests and the Mitsui and Sumitomo groups.

Reflecting the tense business situation in Japan, profits of the Nippon Plate Glass Co. for the second half of 1937 decreased by 45,000 yen to 677,000 yen, as compared with the preceding term, although output and turnover increased in both quantity and value.

With control over importation and consumption of important raw materials gradually becoming tighter, Japanese glass manufacturers are suffering in their operations from a short supply of borax, fluorite, salpeter and cobalt oxide. Further, the soaring prices of coal and heavy oil have proved to be a great blow to the nation's glass industry, declares Dr. Kenji Nakanishi, of Osaka's Industrial Experimental Laboratory, in the *Kagaku Kogyo Jiho* (Chemical Engineering News). Also the supply of silica from China and French Indo-China has been cut off since the outbreak of the current hostilities, with the result that glass makers have to put up with inferior silica from domestic mines. Ichiro Shimada, of the Shimada Glass Works, proposes to search for new silica deposits in the now Japanese-controlled North China region, where, he asserts, the geological formation promises large deposits of high-grade silica. In its past conquests, the Japanese Army has disappointed the glass makers, for neither in Korea nor in Manchukuo have any amounts of glass materials been discovered.

The recent development of the native glass industry has made Japan self-sufficient in special-glass manufactures, excepting optical glasses, says Dr. Toru Takamatsu of the Osaka Industrial Laboratory in the *Kagaku Kogyo Jiho*. Imports are now confined to a few grades which Japanese manufacturers find unprofitable to make because of their limited market. The Osaka Industrial Laboratory, a municipal enterprise, is now preparing to add a 2-ton plant to the 1.5-ton kiln already in operation. The Special Glass Company is also expanding its facilities for production of spectacle glasses.

Russia—Two new fully mechanized plants for the production of glass jars for the preserving industry will shortly commence work. One is at Kherson in the Crimea, the other at Kamyshin in the Volga district and both units will have an annual output of about 100,000,000 glass jars. Russia has no tin.

Sweden—The economic prosperity in Sweden meant a great increase in glass consumption last year, which was supplied by the home industry. This meant that imports of window glass fell from 9,117 tons in 1936 to 7,968 tons, though, on the other hand, 3,918 tons of crude glass were imported against only 3,079. All indices of building activity indicate a further increase of output.

The Amagasaki plant of the Asaki Glass Co. of Japan

CENSUS OF GLASS MANUFACTURE

Blanks have been sent out from the Bureau of the Census asking for information on raw materials, fuel, power, employees, wages and value of product which will be combined into the highly interesting and useful document known as the Biennial Census of Manufactures, 1937.

While these blanks may properly be regarded as additional annoyance by many company officials, they ought to be filled out promptly and with as much accuracy as company records will permit. Examination of previous copies of this census will reveal that it does not contain specific information about any single factory. There need be no fear of unwelcome publicity or the giving of information to competitors. On the positive side, this census enables the individual manufacturer to estimate where his factory stands in comparison with the trade in general, and enables him to plan production more intelligently because of this knowledge.

This compilation furnishes the only figures which may be relied upon in connection with such matters as tariff legislation. In order to be in position to make effective requests for tariff protection, the glass manufacturers must be able to point to genuine statistics as to the extent and character of their operations.

Needless to say, the report is also of great value to the producers and sellers of materials and equipment, and it is obvious that whatever gains in efficiency are made in this direction will eventually be passed on for the benefit of the glass manufacturers.

We join with the director of this census in urging the wholehearted cooperation of our readers in making their returns accurately and promptly.

GLASS COMPANIES NEGOTIATE LABOR AGREEMENTS

Two flat glass manufacturers announce that they have reached satisfactory agreements for 1938 with the Federation of Flat Glass Workers. Both arrangements were concluded at the Federation meeting in Cincinnati, the latter part of January.

The Libbey-Owens-Ford Glass Company's 1937 labor agreement, by its own terms, automatically continues in force for another year without any alteration in wages or working rules. The present agreement provides for wage differential equalizations between Libbey-Owens-Ford and competitors and these matters are under consideration by a subcommittee. The wage differential question will, however, not alter the automatic continuation of the 1937 agreement, which will remain in force until February 1st, 1938.

The other 1938 agreement was concluded between the Federation and the Fourco Glass Co., of Clarksburg, W. Va. A Fourco announcement states that a contributing factor in reaching an amicable settlement was the community of interest between workers and manufacturers to produce an acceptable product at a reasonable price and with profit to all concerned.

A. F. OF L. EXPELS THREE UNIONS

The Federation of Flat Glass Workers was among the three unions expelled from the American Federation of Labor, according to William Green, president of the A. F. of L. The charter of the Glass Workers was revoked because the union had refused to leave John L. Lewis' C. I. O. and because the A. F. of L. executive committee could find nothing to indicate that the Federation of Flat Glass Workers "intended to comply with the constitutional requirements of the A. F. of L." Other C. I. O. unions expelled at the same time included the United Mine Workers of America, and the International Union of Mine, Mill and Smelter Workers.

CHEMISTS PUBLISH MEMBERSHIP

The Association of Consulting Chemists and Chemical Engineers, Inc., New York, has recently published the fourth edition of its membership directory. The book shows the objects and aims of the Association by excerpts from its by-laws, gives a directory of its 54 members and furnishes a series of one-page descriptions of the 41 organizations and firms with which the members are connected. The final section of the directory shows the qualifications of the members in various industrial and chemical categories. A copy of the booklet may be secured from the Executive Secretary at the above address.

SOLUBILITY OF GLASS AND GLASS ELECTRODE DEPARTURES

Applying the method for determining the solubility of optical glasses, described in *Technical News Bulletin* 221 (September, 1935), to a glass which is commonly used for making glass electrodes, the following results were obtained by E. H. Hamilton, Donald Hubbard, and A. N. Finn:

1. The solubility increases rapidly for most alkaline solutions as the pH increases above 8.5 or 9.

2. There is a slight decrease in solubility as the pH changes from 8.5 to 2, but between these concentrations the solubility is much less than for alkalinities above pH 8.5.

3. The solubility decreases rapidly in the acid range beyond pH 2.

Considering these statements in connection with the performance of glass electrodes, these regions of marked solubility change (pH 8.5 and 2) correspond exactly to the two regions of pronounced voltage departures exhibited by electrodes made from this glass.

That the voltage anomalies of the glass electrode are definitely associated with the solubility of the glass has been further demonstrated by the use of glasses which do not have the marked solubility change in the "super acid" region, and by measurements made in alkaline solutions in which soluble silicates are not formed, such as aqueous solutions of ammonia. Under these conditions the voltage departures are very slight.—*Technical News Bulletin* of the National Bureau of Standards, February, 1938.

THE FLUORESCENCE OF GLASS

(*Continued from page* 100)

seems particularly that analysis by fluorescence—if we dare use this term—would be very difficult when several coloring matters are found to be present. On the other hand, it appears that glasses dark in color are not amenable to this method of examination.

The only diagnosis nearly certain, when a rapidly cooled surface is available is the distinction between the rubies with copper, with gold, and with Se-CdS.

On the other hand, we may hope for interesting conclusions from the theoretical point of view.

A. S. T. M. GLASS COMMITTEE TO MEET

Secretary Louis Navias has issued the final call for the regional meeting of Committee C-14 on glass and glass products of the American Society of Testing Materials to be held in Rochester, N. Y., March 8th at the Seneca Hotel. Main business of the meeting will be the receiving of the reports of the sub-committees. Following are the matters to be considered by the advisory committee: 1. representation of C-14 on the general committee, E-1, on methods of testing; 2. representation of C-14 on committee E-8 on nomenclature and definitions; 3. the election of new members. Dr. Navias also reports that the plastics symposium to be sponsored by Committee D-20 on March 9th will be open to members of the glass division.

CANADIANS HONOR ROSS PURDY

At the 36th annual meeting of the Canadian Ceramic Society, Feb. 7-8, Ross Purdy, secretary of the American Ceramic Society, received an illuminated certificate as evidence of the fact that he was unanimously elected an honorary life member of the Canadian society on January 27, 1927. The certificate was signed by Norman B. Davis, president, and Gordon C. Keith, secretary of the Canadian Ceramic Society.

EDWARD ORTON, JR., COMMEMORATION

A program reviewing the career and achievements of Edward Orton, Jr., on the sixth anniversary of his death, was presented to an audience which filled the grand lounge of the Faculty Club at Ohio State University on Feb. 10. The commemoration gathering was sponsored by the American Ceramic Society, the Columbus Chamber of Commerce, the Ohio Geological Survey, Ohio State University, the Edward Orton, Jr., Ceramic Foundation, and General Orton Chapter, Reserve Officers Association of the United States.

After the showing of a series of lantern slides depicting the life of General Orton, with comments by his sister, Mrs. F. C. Caldwell, various phases of his career were presented by several of his friends and contemporaries. The list of speakers included F. A. Ray, Professor Emeritus of Mine Engineering, Ohio State University; Wilbur Stout, State Geologist of Ohio; George A. Bole, Edward Orton, Jr., Ceramic Foundation; A. V. Bleiniger, Homer Laughlin China Co; E. A. Hitchcock, Dean Emeritus, College of Engineering, Ohio State University; Col. Wm. M. Munn, U. S. Army Reserve, Retired, and James A. Maddox of the Columbus Chamber of Commerce.

JANUARY PLATE GLASS PRODUCTION

The production of polished plate glass by member companies of the Plate Glass Manufacturers of America for the month of January, 1938, was 5,119,182 sq. ft., as compared to 8,920,809 sq. ft. produced in December and 6,373,282 sq. ft. produced in January, 1937.

WINDOW GLASS PRODUCTION

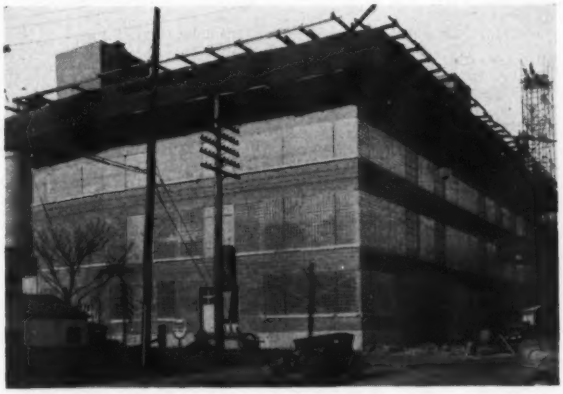
Window glass production during the month of January was 705,721 boxes, which represents 43.5 per cent of industry capacity. This represents a considerable increase over the January, 1937, figures, which were 453,565 boxes, representing only 27.9 per cent of capacity.

LIBBEY BUILDS NEW EXTENSION

Libbey Glass Co., Toledo, will soon occupy the first portion of a new extension to its tumbler factory. The new unit, when completed, will replace four old buildings along Buckeye St., in Toledo, with a modern, up-to-date structure. It will be four stories in height, about 90 feet wide and 310 feet long.

Each floor of the new building is lighted by means of an almost continuous belt of Owens-Illinois Insulux blocks, about 45,000 of these blocks being used in the unit. Machine shops, maintenance shops, factory offices, and rest rooms will be located in the new unit, in addition to the space allotted for manufacturing operations. The extension will not increase the capacity of the plant nor require additional employees, since it simply replaces old buildings which have outlived their usefulness and are being torn down.

Consulting engineers for the new extension are Forster, Wernert & Taylor, of Toledo, and the construction work is being performed by The Austin Company, of Cleveland, general contractors.



USE OF GLASS IN THE CANNING INDUSTRY

The problem of preserving food products in glass containers is being frequently discussed these days by those interested in industrial canning. According to special information we have been receiving, it seems to have been solved in Germany with such interesting results that a great advancement in the process is expected during the coming season. We know that containers for preserved food have not been limited to cans only. Glass too is already widely and almost exclusively used for domestic preserving. Now a large German glass works has just brought out some glass jars supplied with metal rims and rubber rings specially intended for the canning industry. The shape is the same as that of the cans used for preserved food. Besides their dependable sealing and resistance to internal and external pressure, these glasses have the great advantage of perfect shape from the packing point of view. The superiority of glass over tin resides especially in its transparency which permits ready inspection of the condition and quality of the contents. In centres where this new manner of preserving food products has already met with very marked success, people are waiting for the next Spring Fair in 1938 in Leipzig for a very important presentation of innovations, not only of the containers themselves but also of accessory and filling materials, etc.—*From Verre et Silicates Industriels, Dec.* 25, 1937.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	43.00	46.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	....	....
Granulated	In bags, lb.	.021	.0255-.028
Powdered	In bags, lb.	.0235	.028-.0305
Boric acid (H_3BO_3) granulated	In bags, lb.	.0475	.0525-.055
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite ($Na_3Al F_6$) Natural Greenland (Kryolith)	lb.	.0875	.0925
Synthetic (Artificial)	lb.	.0875	.0925
Feldspar—			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	31.50	....
In bags	ton	33.10	38.00-40.60
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.07	....
In 5 Ton lots	lb.	....	.075
Less than 5 Tons	lb.	....	.08
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	....
Burnt (CaO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	....
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.25	2.25
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065	.0675
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4)	ton	16.00	27.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	.95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	Per 100 lb.	....	2.50-2.90
95% and 97%			
Bulk	Per 100 lb.	1.35	....
200 lb. bags		1.415	1.44
100 lb. bags		1.45	1.475

Special Materials

		Carlots	Less Carlots
Aluminum hydrate (Al $(OH)_3$)	lb.	....	.03½
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Antimony oxide (Sb_2O_3)	lb.	.12½	.13
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03	.03½
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	.07¾
Rutile (TiO_2) powdered, 95%	lb.	.11-.12	.13-.15
Sodium fluosilicate (Na_2SiF_6)	lb.	.05½-.05¾	.06
Tin Oxide (SnO_2) in bbls.	lb.	....	.47
Zinc Oxide (ZnO)			
American process, Bags	lb.	.06¾	.06½
White Seal, 150 lb. bbls.	lb.	.08¾	.09
Green Seal bags	lb.	.08	.08¾
Domestic White Seal bags	lb.	.08½	.08¾
Red Seal, bags	lb.	.07½	.07¾
Zircon			
Refined Granular (Milled .005-.02c higher)		.07	0.7½-.08
Commercial, Gran. (Milled .005-.02c higher)		.03	.04-.05

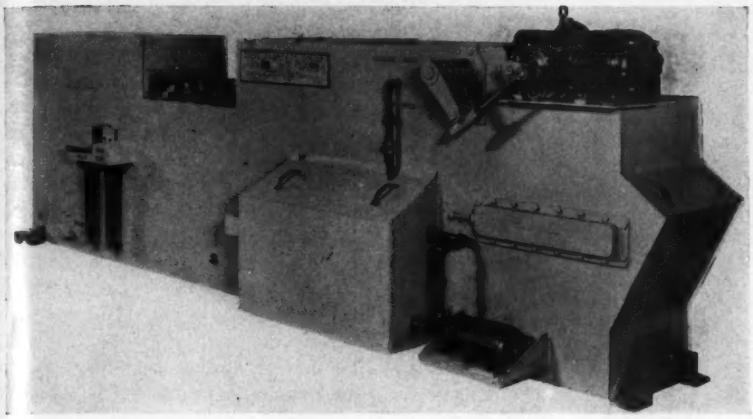
Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.50-1.75
(Commercial, 25% Selenium)	lb.	....	.90
Cadmium sulphide (CdS)	lb.	....	1.25-1.35
Chromite (99% through 200 mesh)	lb.	37.00	40.00
Cerium hydrate			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.22-.26
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	....	1.67
In 10 lb. tins	lb.	....	1.77
Copper oxide			
Red (Cu_2O)	lb.	....	.20¼
Black (CuO)	lb.	....	.14½-.17½
Black prepared	lb.	....	.22
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.0425
Black (Fe_3O_4)	lb.	.04½	....
Iron Chromate	lb.	....	.035-.05
Lead Chromate ($PbCrO_4$)	lb.	....	.16
Manganese, Black Oxide			
In Paper bags	ton	57.00	64.50-66.50
In Burlap bags	ton	65.50	67.50-69.50
In Casks	ton	70.50	72.50-74.50
Neodymium oxalate, 50 lb. drums	lb.	....	3.50
Nickel oxide (Ni_2O_3), black	lb.	....	.35-.40
Nickel monoxide (NiO), green	lb.	....	.35-.40
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.08¾	.0925
Powdered	lb.	....	.0975
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.2075-.2125
Pyrophyllite, Standard Grade	lb.	9.00	12.00
Rare earth hydrate			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	2.00
In lesser quantities	lb.	....	2.10
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¾	.0725
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	.08¼	.08½
Sodium selenite (Na_2SeO_3)	lb.	....	1.80-2.00
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.50-1.55
Yellow	lb.	....	1.50-1.55
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.25
Yellow orange	lb.	....	1.50

Polishing Materials

		Carlots	Less Carlots
Emery, Turkish	lb.	....	.07
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	.03
0, 0½, ½, 1	lb.	....	.03¾
Putty Powder	lb.	....	.38-.42
Rotten Stone	lb.	....	.03
Rouge, Red	lb.	....	.14
Black	lb.	....	.16

EQUIPMENT AND SUPPLIES



CLEVELAND UNION BOTTLE WASHER

The Cleveland Union Engineering Co., Cleveland, is now marketing an additional model of its line of bottle washing machines, called the Simplex Junior. Built in four sizes with capacities from 14 to 30 bottles per minute, this model is a brushless washer and is being used by some of the leading glass companies to clean bottles after the annealing operation.

As shown in the accompanying illustration, the Simplex Junior washer consists of a heavy sheet-steel housing, welded and braced against distortion, through which the bottles are carried by an intermittently moving conveyor. For glass manufacturing plant use the bottles are given a series of hydro treatments, with the proper ingredients in the solutions to remove bloom from the ware, followed by a final rinsing.

Bottles are loaded into the conveyor pockets in an open space at the top of the machine and pass into the enclosure at the far end where they may receive an initial inside spray from suitable jets. Passing over the conveyor sprocket at the end of the machine, the bottles are then placed on a shelf in the solution tank at the bottom of the machine, along which they are moved by the intermittent action of the conveyor. The solution tank extends the entire length of the machine and the ware is given a thorough soaking before it reaches the other conveyor sprocket.

As the bottles rise out of the solution at the end of the machine they are automatically turned neck down again by the action of the conveyor and the solution drains out. The final rinsing is done by jets located in the top of the machine housing, the rinsing solution being forced to the jets from a tank at the side of the machine by a motor-driven pump. After the final rinse the bottles are removed from the conveyor pockets in the open space at the top of the machine.

CATALOGS RECEIVED

George Gorton Machine Co., Racine, Wis., has just issued a new Bulletin 1322-A, describing their complete line of die and mould duplicating machines. These three-dimensional pantograph machines are offered for use where precise detail is required and will reproduce designs from models or patterns larger than the work, and reductions from ½ to ⅛ size of model can be obtained. Several pages of this new bulletin are devoted in text and illustration to glass mould duplication for various types of glassware.

Surface Combustion Corporation, Toledo. A well-illustrated bulletin entitled, "Wherever Heat is Used in the Glass Industry," describes many glass plant applications of S-C equipment in cluding annealing lehrs, decorating lehrs, utility lehrs, special process lehrs, day tanks, recuperators and burners.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin No. 2118 covers Type 30 small industrial compressors and vacuum pumps, ranging in size from ¼ to 15 horsepower. Complete rating tables on more than fifty models are given, together with dimensions and shipping weights.

South Bend Lathe Works, South Bend, Ind. A new 72-page general catalog No. 97, which describes and illustrates the entire line of back-geared, screw-cutting, precision lathes which the company manufactures. The catalog also shows the complete line of attachments which may be fitted to South Bend lathes, as well as the chucks and tools.

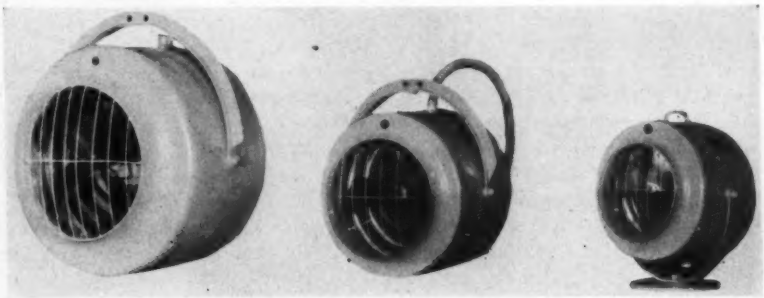
ADDITION TO INDUSTRIAL HEATING LINE ANNOUNCED

A larger forced-convection heater with greater heating capacity has recently been announced by the General Electric Co., Schenectady, N. Y., to provide a heavy-duty, exclusively wall- or ceiling-mounted unit in the G-E line of industrial heaters. Including the new type, three physical sizes of heaters are now available: the small, portable size in ratings of 2, 3 and 4 kw.; the intermediate size, suspension style, in ratings of 5 and 7½ kw., and the new suspension style in ratings of 10, 12½, and 15 kw. All heaters are available for 230 volts, 60 cycles, the small and intermediate sizes being single-phase and the large size three-phase.

While the primary application of all G-E forced-convection heaters is directed space heating, the two smaller sizes can be utilized as air circulators or fans. This is made possible by use of switches provided for operating the aphonic, pressure-type fan independent of the heating element.

The line affords a wide range of heating capacities. The lowest rating—that of the smallest unit in the line—is projection of 200 cu. ft. of air per minute, at a velocity of about 700 ft. per minute. Capacity ranges upward through the different types until, in the case of the newly announced suspension type, volume is 1,590 cu. ft. per minute, with velocity of about 1,780 ft. per minute. Outlet temperatures remain nearly the same in all types and sizes.

Throughout the line, G-E Calrod heating units are brazed to strong radiating fins in order to assure the maximum in heat-transfer efficiency. The motor is totally enclosed, has sleeve bearings, and an ingenious baffle plate protects it from direct radiation. Thermostatic cutouts protect it from overheating by accident.



ABSTRACTS OF A. C. S. PAPERS

(*Continued from page 94*)

ically the motion of the mason's trowel, and all mortars were tested for ease of spreading on fire brick for four different periods of time. After drying on the brick, it was noted whether the mortars had cracked and pulled from the brick. The transverse strengths at ordinary temperatures of the unheated materials, as well as those of the materials after having been heated at several temperatures were determined. The mortars were tested for bonding strength after similar heat treatments.

Shrinkage of Insulating Refractories. *By S. M. Phelps and E. C. Petrie, American Refractories Institute.*

This paper presents the results of an extensive test methods study for the purpose of determining the shrinkage of insulating materials to be used as exposed linings in furnaces. Test methods and data are given for a number of brands tested in various procedures employing soaking heat and as sections of the furnace wall or the panel test. There are also presented the effects obtained from reducing gas atmospheres.

Influence of Alumina Coatings on Resistance of Refractories to Slag Action. *By H. G. Schurecht, New York State College of Ceramics.*

Aluminum coatings applied to refractories were found to greatly increase their resistance to slag action.

Some Relationships Between Various Physical Properties of Insulating Refractories. *By Carl E. Curtis, Simonds Worden White Co.*

Data concerning the various physical properties of several brands of insulating refractories are plotted together. From the resulting figures, conclusions are drawn concerning the relationships between the various properties. In connection with the permeability data, a specimen holder especially adapted for use in determining the permeability of insulating brick is described.

Recent Developments in Refractory Patching Materials for Glasshouse Usage. *By H. D. Frankel, Jr., Chicago Fire Brick Co.*

Commercial application in glass plants during the past eighteen months, involving a new type of refractory patching material, have produced a means of preventing glass and gas leakage in certain portions of tanks. Similarly, gas leakage, air infiltration, and erosion have been prevented in recuperators, regenerators, and boilers. Patches of this material have shown a high degree of permanence.

The Linear Thermal Expansion of "Beta-Alumina". *By J. B. Austin, U. S. Steel Corporation.*

An attempt to determine the linear thermal expansion coefficient of a sample of "beta-alumina" containing 4.47 per cent K_2O and 1.03 per cent Na_2O was unsuccessful because the expansion was irregular and not reproducible. On successive heatings, the expansion approached more and more closely that of alpha alumina (corundum). This observation, together with the fact that the fused silica parts of the expansion apparatus were badly etched during the measurments apparently by alkali given off by the sample, gives further support to the view that "beta-alumina" is not an allotropic form of pure alumina but is an alkali aluminate.

A New Abrasion Test—Results on Enamels and Other Products. *By L. Shartsis and W. N. Harrison.*

A test for abrasion resistance has been developed, primarily for use with vitreous enamels, but with promise of applicability to other materials such as glazed ceramic ware, glass, plastics, paints, lacquers, etc. The method of abrasion consists of placing small spherical weights on the face of a flat specimen, confining these materials within a walled-in area and agitating the assembly in a horizontal plane, in such manner that a multi-directional effect is obtained. Water is customarily added to avoid the effect of variations in atmospheric humidity. A commercial screen shaker has been used for this agitation, which is of prescribed character and duration. The specular gloss of the specimen is determined by photo-elastic means before and after the test, and the percentage of the original specular gloss retained after the test is taken as the abrasion index. Different vitreous enamels tested by this method have had abrasion index values as high as 82 and as low as 15, as well as intermediate values.

Fundamental Properties of Nepheline Syenite. *By C. J. Koenig, Engineering Experiment Station, Ohio State University.*

Fundamental properties of nepheline syenite such as thermal expansion and fusion characteristics are given. Test specimens of 12 bodies, comprising various flux combinations of nepheline syenites and potash feldspars with talc, whiting, magnesium carbonate, and pyrophyllite, were fired to seven different cones. The firing linear shrinkage curves of combinations of nepheline syenite with the test materials are somewhat similar to such combinations with potash feldspar except that the syenite combinations are active at lower temperatures. Sintering ranges of nepheline syenites are longer than those of potash feldspar. This is explained thermochemically.

INSTITUTE OF CERAMIC ENGINEERS

One hundred and fifty-four members of the American Ceramic Society have already applied for membership in the founders group of the Institute of Ceramic Engineers. All of these applicants had degrees from ceramic engineering schools and were graduated prior to 1927. It is expected that after the first formal inaugural meeting of the Institute in New Orleans, Monday, March 28th, further applications will be received. The Rules Committee for the new organization consists of: Chairman, A. F. Greaves-Walker; S. J. McDowell, General Ceramics Co; H. N. Baumann, Jr., Carborundum Co; H. G. Wolfram, Porcelain Enamel & Mfg. Co; Professor J. W. Whittemore, Virginia Polytechnic Institute. J. L. Carruthers, Ohio State University, is temporary chairman.

GLASS DIVISION NOMINATIONS

The Glass Division Nominating Committee of the American Ceramic Society have nominated the following officers for the year 1938-1939: Chairman, L. C. Roche; Vice-Chairman, N. W. Taylor; Secretary, S. R. Scholes; Trustee, D. E. Sharp; Nominating Committee "A," George W. Morey; Nominating Committee "B," James Bailey. The Committee advises that other names may be written in on the ballot.

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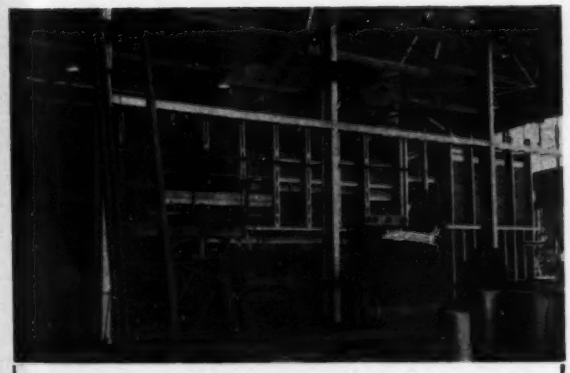

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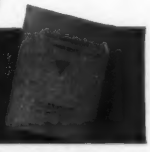

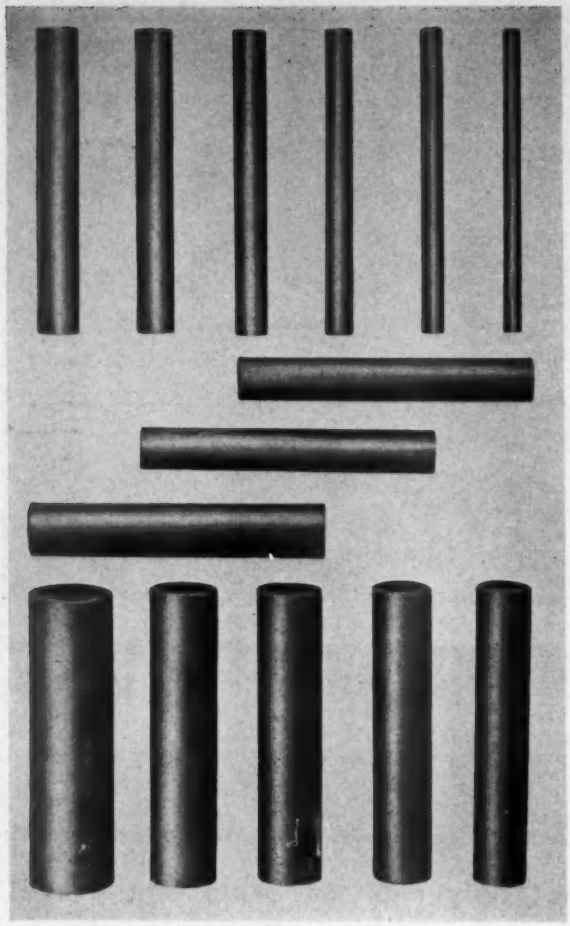

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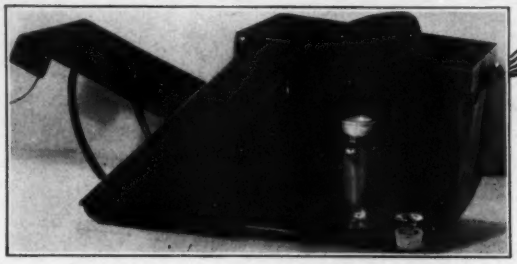

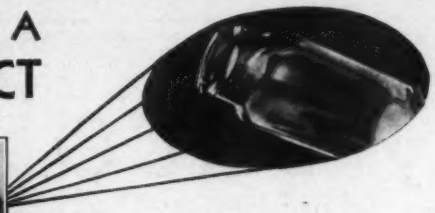

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